GUIDE TO USING 1995-1997

MARYLAND BIOLOGICAL STREAM

SURVEY DATA

Prepared for

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FOREWORD

This report, *Guide to Using 1995-1997 Maryland Biological Stream Survey Data,* supports the Maryland Department of Natural Resources' Maryland Biological Stream Survey (MBSS) under the direction of Dr. Ronald Klauda and Mr. Paul Kazyak of the Monitoring and Non-Tidal Assessment Division. This report was prepared under Maryland's Power Plant Research Program under the direction of Dr. John Sherwell (Contract No. PR-96-055-001 to Versar Inc.). The report contains a description of the content of 1995-1997 Maryland Biological Stream Survey (MBSS) data sets and formats for individual data elements in those data sets. The purpose of this report is to facilitate the use of the 1995-1997 data by those interested in these data for ecological assessments.

The MBSS is a cooperative effort among several agencies and consultants, including Maryland Department of Natural Resources; Maryland Department of the Environment; University of Maryland Appalachian Laboratory; University of Maryland Agricultural Experiment Station; Post, Buckley, Schuh, and Jernigan, Inc.; and Versar, Inc. The authors wish to acknowledge the contributions of those who assisted in the collection, entry, and compilation of the 1995-1997 MBSS data. We particularly thank Scott Stranko, Tony Prochaska, Marty Hurd, Helen Dail, and Suzanne Kelly of DNR for assistance in data entry and management. We also thank Mark Southerland, Don Strebel, Sharon Honeycutt, Allison Brindley, and Gail Lucas of Versar for their contributions to this report.

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1 OVERVIEW

1.1 THE 1995-1997 MARYLAND BIOLOGICAL STREAM SURVEY

The Maryland Biological Stream Survey (MBSS or Survey) is a comprehensive program that is supported and led by the Maryland Department of Natural Resources (DNR) to assess the status of biological resources in Maryland's non-tidal streams; quantify the extent to which acidic deposition has affected or may be affecting critical biological resources in the state; examine which other water chemistry, physical habitat, and land use factors are important in explaining the current status of biological resources in streams; establish a benchmark for long-term monitoring of trends in these resources; and target future local-scale assessments and mitigation measures needed to restore degraded biological resources. To meet these and other objectives, the Survey has established a list of questions of interest to environmental decision makers to guide its design, implementation, and analysis. These questions fall into three categories: (1) characterizing biological resources and ecological conditions (such as the number of fish in a watershed or the number of stream miles with pH < 5), (2) assessing the condition of these resources (as deviation from minimally impacted expectations), and (3) identifying likely sources of degradation (by delineating relationships between biological conditions and anthropogenic stresses).

The MBSS was implemented in several stages, including (1) devising a sampling design to monitor non-tidal streams throughout the state, (2) implementing sampling protocols and quality assurance/quality control procedures to assure data quality and precision, (3) developing indicators of biological condition so that degradation can be evaluated as a deviation from reference expectations, and (4) using a variety of analytical methods to evaluate the relative contributions of different anthropogenic stresses.

The 1995-1997 MBSS used a special probability-based survey design called lattice sampling to assess conditions in all 17 major drainage basins in Maryland over the three year sampling period. The lattice design effectively stratified by year and basins and restricted the sampling each year to about one-third of the state's major drainage basins. This restriction was employed to optimize the efficiency of the field effort by minimizing the travel time between sampling locations. Approximately 300 stream segments of fixed length were sampled each year, with biological, chemical, and physical parameters measured at each segment using standardized methods. Biological measurements included abundance and health of fish, composition of benthic macroinvertebrate communities, and presence of amphibians and reptiles, aquatic plants, and mussels. Chemical measurements included pH, acid-neutralizing capacity (ANC), sulfate, nitrate-nitrogen, conductivity, dissolved oxygen and dissolved organic carbon (DOC). Numerous physical habitat measurements were assessed including flow, stream gradient, maximum depth, thalweg depth, wetted width, temperature, the number of rootwads and woody debris, embeddedness, instream habitat, epifaunal substrate, pool and riffle quality, bank stability, channel flow status, shading, and riparian buffer type. The presence of storm drains, effluent discharge, and beaver ponds was also recorded. The aesthetic value and remoteness of each site were quantified based on evidence of human activity at each site. Regional land cover data (MRLC 1996a,b) were used to characterize catchment land uses.

Several indicators of the biological health of the streams sampled in the 1995-1997 MBSS were developed from the data collected above. A fish Index of Biotic Integrity (IBI; see Roth et al. 1998a) and a benthic IBI (Stribling et al. 1998) were used to assess the condition of both the fish and benthic macroinvertebrate communities by comparing the species assemblages found at each site to minimally impacted reference sites found throughout the state. IBI scores used for the 1995-1997 MBSS are the mean of several individual metric scores and range from 1 (very poor) to 5 (good). The Hilsenhoff Biotic Index (Hilsenhoff 1977, 1987, 1988; Klemm et al. 1990; Plafkin et al. 1989) and the number of EPT taxa (taxa found in the families Ephemeroptera, Plecoptera, and Trichoptera) were also used to evaluate the health of benthic communities. A reference-based Physical Habitat Index (PHI) was developed (Hall and Morgan 1999) as a means of summarizing a variety of important habitat metrics.

Several reports documenting MBSS results are available. A Pilot Study was conducted in 1993 (Vølstad et al. 1995) to (1) evaluate the logistical protocols involved in field sampling, (2) evaluate the adequacy of the sample design, and (3) refine estimates of time requirements and cost to implement a full-scale MBSS. This was followed by a statewide Demonstration Project in 1994 (Vølstad et al. 1996) that incorporated changes in sampling design and logistics that resulted from the Pilot Study. Results from the basins sampled in the 1995 and 1996 sample years are also reported (Roth et al. 1997, 1998b). 1995-1997 statewide and basinwide results are reported in the MBSS three-year report (Roth et al. 1999).

1.2 THE DATA USERS GUIDE

The *Guide to Using 1995-1997 Maryland Biological Stream Survey Data* and its accompanying data sets include data from the 1995-1997 MBSS sampling years. Data sets are available as comma-delimited ASCII files. This guide provides written documentation and explanation of the information in the 1995-1997 database. Chapter 2 contains background information on the MBSS, including an explanation of the 1995-1997 sampling design and an overview of laboratory and fields methods. More detailed information on methods may be found in the MBSS sampling manual (Kazyak 1997). Chapter 3 describes the contents of each data set. Variables listed in the each of the data sets are defined and additional information is provided to assist users in interpreting and analyzing MBSS data. Chapter 4 gives some guidelines for data analysis. Sample data field data sheets are found in Appendix A. Appendix B lists names of benthic taxa collected in the 1995-1997 Survey.

1.3 CONTACT FOR DATA AND INFORMATION

MBSS data sets, program reports, and other information are available upon request. A copy of the data request form is included here as Figure 1-1.

MBSS Information and Data Request Form

Please complete the following information to the best of your knowledge. Requests will be filled in the order that they are received. We will try to complete requests by the date needed; however, we cannot guarantee delivery by the date specified.

DATE recv'd _________
DATE filled:__________

NAME:____

ADDRESS:____
____
____
____

PHONE #:___________________________ FAX #:_________________________

DATE INFORMATION IS NEEDED:______________ E-MAIL:__________________________________

FOR GENERAL INFORMATION ABOUT THE MARYLAND BIOLOGICAL STREAM SURVEY (MBSS):
See attached list of publications

DO YOU WISH TO BE ADDED TO THE MBSS NEWSLETTER MAILING LIST:_______

FOR COPIES OF THE DATA SETS, PLEASE COMPLETE THE FOLLOWING SECTIONS:

MAJOR RIVER BASIN(S): (Please check all needed)
__Youghiogheny River __North Branch Potomac River __Upper Potomac River __Middle Potomac River __Conewago Creek
__Potomac-Washington Metro __Lower Potomac River __Patuxent River __West Chesapeake __Patapsco River
__Bush River __Gunpowder River __Elk River __Lower Susquehanna River__Chester River
__Choptank River __Pocomoke River __Nanticoke-Wicomico Rivers __Ocean Coastal
__ All Basins In Maryland

COUNTY:____

SPECIFIC STREAM NAME:____

OTHER INFORMATION THAT WILL HELP US TO LOCATE THE AREA OF INTEREST:____
____

INFORMATION REQUESTED: (Please check all needed)
__Fish __Habitat __Fish IBI Scores __Macroinvertebrates (Benthos) __Herpetofauna __Water Quality
__SAV (Submerged Aquatic Vegetation) __Mussels __Sample Sites Location Coordinates_ Stream Names
__Other (Please Specify):____

HOW WOULD YOU LIKE THE INFORMATION SENT TO YOU:
__E-mail __Fax __Mail (Please Specify: __Digital __Hardcopy)
reason for request (use of data):____
____
____

If you have any questions about this form please call Dan Boward (410-260-8605) or Ron Klauda (410-260-8615).
Send completed form to:

Scott Stranko
Maryland Department of Natural Resources
Monitoring & Non-Tidal Assessment Division
580 Taylor Avenue, C-2
Annapolis, Maryland 21401
sstranko@dnr.state.md.us

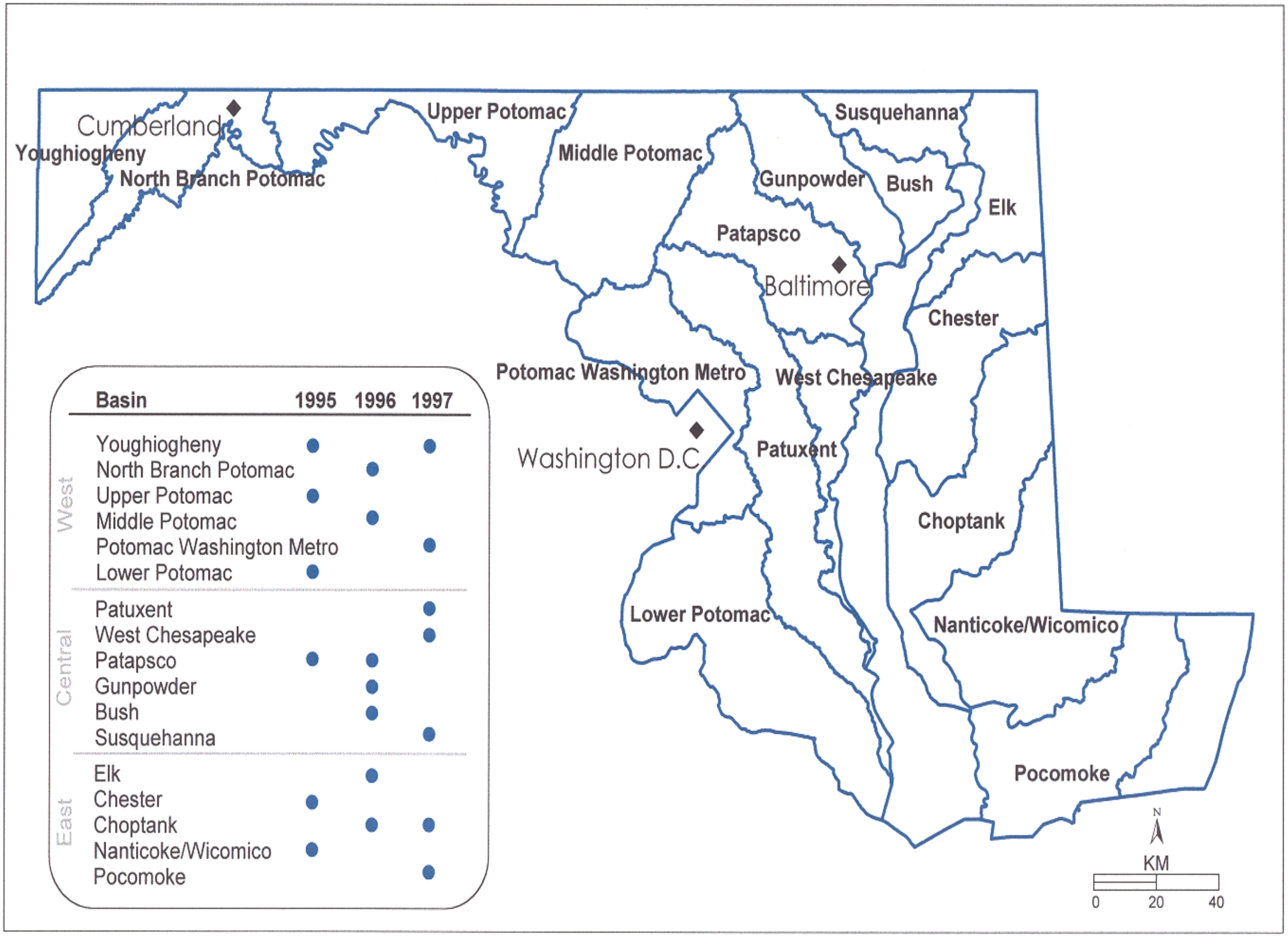
2 GENERAL DESCRIPTION

2.1 1995-1997 MBSS STUDY DESIGN

The 1995-1997 MBSS was a multi-year sampling program for assessing the status of biological resources in non-tidal streams of Maryland and how they are affected by acidic deposition and other factors. The MBSS study area is comprised of 17 distinct drainage basins (Figure 2-1). Because it would have been prohibitively costly to visit sites in all basins in a single year, lattice sampling was used to schedule sampling of basins over a three-year period. Lattice sampling, also known as multistratification, is a cost-effective means of allocating effort across time in a large geographic area (see Cochran 1977, Jessen 1978). A table, or lattice, was formed by arranging the basins in 17 rows, and the years in three columns. Lattice sampling was the method used for selecting cells from this 17x3 table so that all cells would be sampled over a three-year period (Figure 2-1). Although originally included in the sample design, the Conewago basin was not sampled as part of the Survey's random sampling, because its small number of non-tidal stream miles would not permit accurate estimates of basin characteristics. However, in 1997, three sites chosen in a non-random manner in the Conewago basin were sampled using MBSS methods. Similarly, three non-random sites were sampled in the Ocean Coastal basin in 1997 to provide an overview of conditions there. The data sets provided here include information only from the randomly selected sites in the 17 major drainage basins in the state.

The MBSS study area was divided into three geographic regions with five to seven basins each: (1) western, (2) central, and (3) eastern. This geographic stratification facilitated the effective use of three sampling crews from the different regions. Two basins were randomly selected (without replacement) from each region for sampling each year. One randomly selected basin in each region was visited twice, in order to quantify between-year variability in the response variables. This controlled selection of cells from the lattice allows estimation of average condition for all cells; i.e., the average condition for all basins over a three-year period.

The sampling frame for the three year study was constructed by overlaying basin boundaries on a map of all blue line stream reaches in the study area as digitized on a U.S. Geological Survey 1:250,000 scale map. The Strahler convention (Strahler 1957) was used for ranking stream reaches by order; first order reaches, for example, are the most upstream reaches in the branching stream system. Sampling was restricted to non-tidal, third-order and smaller stream reaches, excluding impoundments that were non-wadable or that substantially altered the riverine nature of the reach (Kazyak 1997). Stream reaches were further divided into non-overlapping, 75-meter segments; these segments were the elementary sampling units for which biological, water chemistry, and physical habitat data were collected.



	Basin	1995	1996	1997
West	Youghiogheny	●		●
	North Branch Potomac		●	
	Upper Potomac	●		
	Middle Potomac		●	
	Potomac Washington Metro			●
	Lower Potomac	●		
Central	Patuxent			●
	West Chesapeake			●
	Patapsco	●	●	
	Gunpowder		●	
	Bush		●	
	Susquehanna			●
East	Elk		●	
	Chester	●		
	Choptank		●	●
	Nanticoke/Wicomico	●		
	Pocomoke			●

Figure 2-1. Basins in the MBSS study area and the years scheduled for sampling in the 1995-1997 survey

The 1995-1997 MBSS was restricted to first-, second-, and third-order streams in Maryland, as determined from the 1:250,000 scale base map. It is important that the stream systems to be included in the survey be precisely described in terms of the extent, location, and order of each type of stream. Only by reference to these "total stream miles" (Table 2-1) can estimates of the percentage of the resource with certain attributes be converted to the total amount of the resource.

Table 2-1. Number of stream miles by stream order for basins sampled in the Maryland Biological Stream Survey

Basin	Order 1	Order 2	Order 3	Combined
Youghiogheny	244.0	87.2	43.1	374.3
North Branch Potomac	386.9	130.0	77.3	594.2
Upper Potomac	463.9	161.9	42.8	668.6
Middle Potomac	742.0	230.5	129.9	1102.4
Potomac Washington Metro	491.4	119.6	78.2	689.2
Lower Potomac	502.6	100.0	48.4	651.0
Patuxent	698.1	157.4	53.2	908.7
West Chesapeake	180.3	29.1	10.8	220.2
Patapsco	422.6	134.1	60.0	616.7
Gunpowder	348.5	74.8	42.8	466.1
Bush	131.0	31.3	23.8	186.1
Susquehanna	208.2	42.3	24.7	275.2
Elk	162.9	37.5	11.3	211.7
Chester	216.6	64.2	10.3	291.1
Choptank	208.7	32.1	16.1	256.9
Nanticoke/Wicomico	192.8	28.7	5.5	227.0
Pocomoke	219.4	38.0	13.6	271.0
TOTAL	**5819.9**	**1498.7**	**691.8**	**8010.4**

The 1995-1997 MBSS study design was based on stratified random sampling of segments within each basin; each basin was stratified by stream order (orders 1-3; Figure 2-2). Random sampling of segments within each basin and stream order allows the estimation of unbiased summary

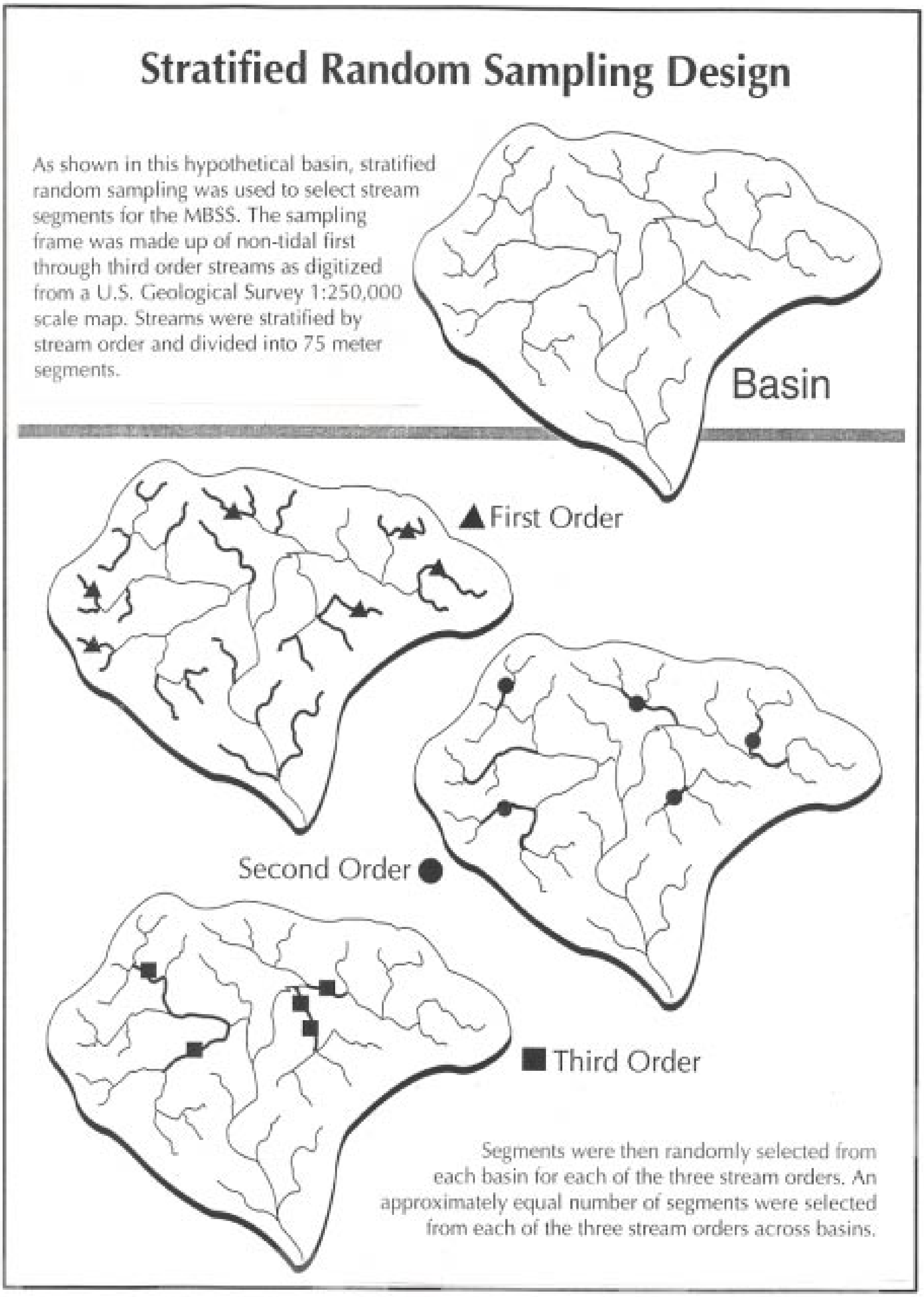


Figure 2-2. MBSS stratified random sampling design

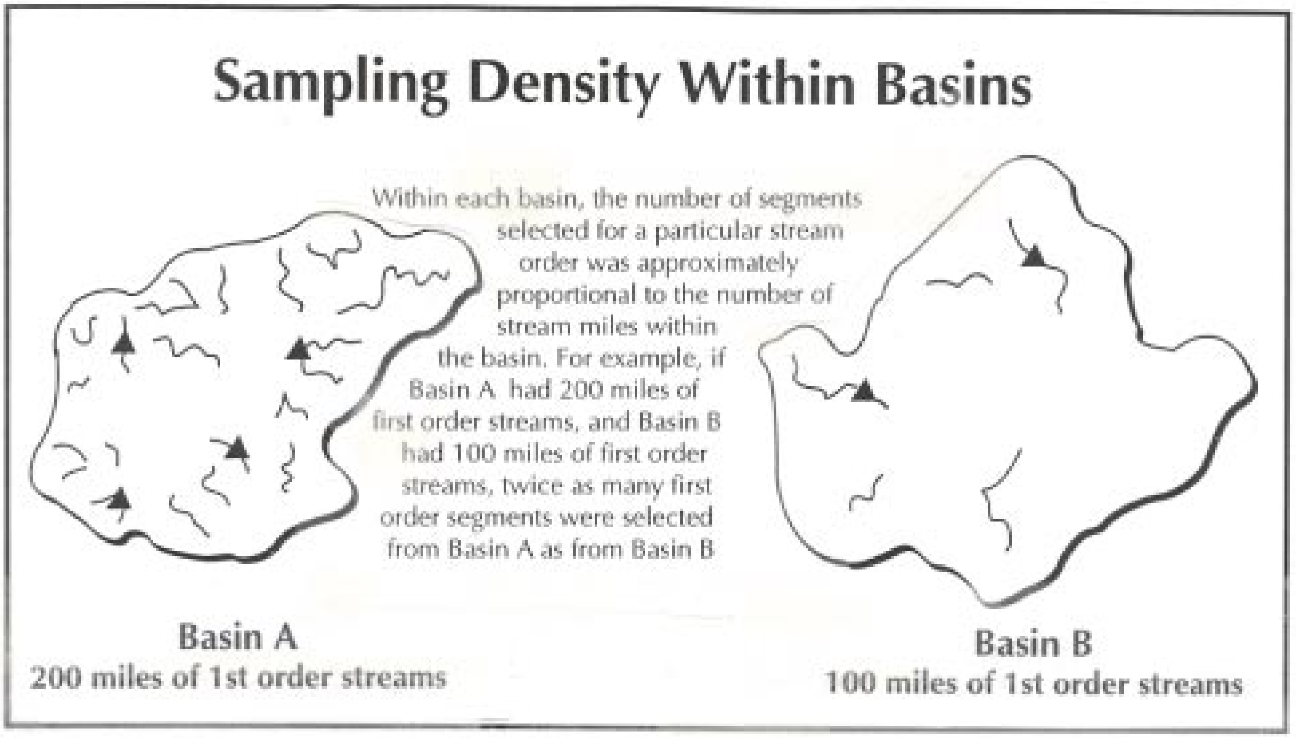


Figure 2-2. Continued

statistics (e.g., means and proportions, and their respective variances) for the entire basin, or for subpopulations of special interest (see Roth et al. 1999 for details). Approximately equal numbers of stream segments were sampled from each stream order across the 17 basins. The number of samples was approximately proportional to the number of stream miles in a basin.

To achieve the target number of samples per stream order within each basin, a given number of segments were randomly selected from each basin and ranked in order of selection. Extra segments were selected as contingency against loss of sampling sites from restricted access to selected streams or from streams that were dry. Permissions were obtained to access privately owned land adjacent to or near each stream segment. The procedures for obtaining permissions are described in Chaillou (1995). In all, 955 stream segments were successfully sampled in the spring during 1995-1997; of those, 905 were sampled in summer (Table 2-2).

Table 2-2. Number of stream sites sampled by stream order and basin for the 1995-1997 MBSS

Basin	Order 1		Order 2		Order 3		Combined	
	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
Youghiogheny 1995	13	11	14	13	14	14	41	38
Youghiogheny 1997	12	11	17	17	15	14	44	42
North Branch Potomac	17	14	22	20	23	23	62	57
Upper Potomac	23	19	31	31	15	15	69	65
Middle Potomac	29	29	39	37	41	41	109	107
Potomac Washington Metro	23	22	22	22	26	26	71	70
Lower Potomac	20	19	19	16	15	15	54	50
Patuxent	35	35	29	28	18	17	82	80
West Chesapeake	11	10	12	10	12	12	35	32
Patapsco 1995	18	18	23	23	20	20	61	61
Patapsco 1996	21	21	25	25	22	19	68	65
Gunpowder	18	18	13	13	14	14	45	45
Bush	6	6	6	5	8	8	20	19
Susquehanna	13	12	12	12	12	11	37	35
Elk	7	7	7	7	4	4	18	18
Chester	15	13	12	12	15	14	42	39
Choptank 1996	10	7	6	6	5	5	21	18
Choptank 1997	11	8	8	5	6	6	25	19
Nanticoke/Wicomico	11	11	6	6	0	0	17	17
Pocomoke	12	9	10	7	12	12	34	28
TOTAL	325	300	333	315	297	290	955	905

2.2 FIELD AND LABORATORY METHODS

Sampling procedures for the 1995-1997 MBSS followed procedures specified in the MBSS Sampling Manual (Kazyak 1997). A summary of the parameters measured and the methods used to conduct the sampling follows. Example data sheets for the spring and summer index periods are found in Appendix A.

2.2.1 Spring and Summer Index Periods

Nine hundred fifty-five stream segments were sampled during the spring sampling periods of 1995-1997 (Table 2-2). Benthic macroinvertebrate and water quality sampling was conducted in spring, when the benthos are thought to be reliable indicators of environmental stress (Plafkin et al. 1989). Fish, amphibian and reptile, macrophyte, and mussel sampling, along with physical habitat evaluations, were conducted at 905 segments during the low flow period in summer. The effects of spawning migration on fish communities is minimal during summer, and low flow is advantageous for electrofishing. Because low flow conditions in summer may be a primary factor limiting the abundance and distribution of fish populations, habitat assessments were performed during the summer. The sample size in summer is lower than in spring because some streams were ephemeral (dry in summer) or otherwise unsampleable.

To reduce temporal variability, sampling during spring and summer was conducted within specific short time intervals, referred to as index periods (Janicki et al. 1993). The spring index period was selected as the time period between about March 1 and May 1, and the summer index period was between about June 1 and September 30 (Kazyak 1997). Actual dates for the spring index period depended on degree-day calculations specific to each year.

2.2.2 Water Chemistry

During the spring index period, water samples were collected at each site for analysis of pH, acid neutralizing capacity (ANC), conductance, sulfate, nitrate-nitrogen, and dissolved organic carbon (DOC). These variables describe basic water quality conditions with an emphasis on factors related to acidic deposition.

Grab samples were collected in one-liter bottles for analysis of all analytes except pH. Water samples for pH were collected with syringes, which allowed purging of air bubbles to minimize changes in carbon dioxide content (EPA 1987). Samples were stored on wet ice and shipped on wet ice to the analytical laboratory within 48 hours.

Chemical analysis of water samples followed standard methods described in EPA's Handbook of Methods for Acid Deposition Studies (EPA 1987). These methods are summarized in Table 2-3. EPA protocols were followed except ANC sample volume was reduced to 40 ml to ease sample handling. Routine daily quality control (QC) checks included processing duplicate, blank, and calibration samples according to EPA guidelines for each analyte. Routine QC checks helped to identify and correct errors in sampling routines or instrumentation at the earliest possible stage.

Table 2-3. Analytical methods used for water chemistry samples collected during the spring index period of the 1995-1997 MBSS. See EPA (1987) for details.

Analyte (units)	**Method**	**Instrument**	**Detection Limit**	**Holding Time (days)**
pH (standard units)	EPA Sec. 19.0	Closed system using Orion 611 pH meter equipped with Orion 08104 Ross combination electrode and Hellman chamber	0.01	7
Specific Conductance (μmho/cm)	EPA 120.1	YI 32 equipped with 3403 conductivity cell (1.0 cm/sec cell constant)	NA	14
Acid Neutralizing Capacity (μeq/l)	EPA Sec. 5.0 modified	Titration (modified Gran analysis) using Orion 611 pH meter	NA	14
Dissolved Organic Carbon (mg/l)	EPA 415.1	Doorman DC-80 carbon analyzer	1.0	14
Sulfate (mg/l)	EPA 300.0	Danaus 2001i ion chromatography (with upgrade)	0.206	14
Nitrate- Nitrogen (mg/l)	EPA 300.0	Danaus 2001i ion chromatography (with upgrade)	0.013	14

NA = Not Applicable

During the summer index period, *in situ* measurements of dissolved oxygen (DO), pH, temperature, and conductance were collected at each site to further characterize existing water quality conditions that might influence biological communities. Measurements were made at an undisturbed section of the segment, usually in the middle of the stream channel, using electrode probes. Instruments were calibrated daily and calibration logbooks were maintained to document instrument performance.

2.2.3 Benthic Macroinvertebrates

Benthic macroinvertebrates were collected to provide a qualitative description of the community composition at each sampling site (Janicki et al. 1993). Sampling was conducted during the spring index period. Benthic community data was used to calculate biological metrics, such as those described in EPA's Rapid Bioassessment Protocols (Plafkin et al. 1989), and to develop a benthic IBI for Maryland streams (Stribling et al. 1998).

At each segment, a 600 micron mesh "D" net was used to collect organisms from habitats likely to support the greatest taxonomic diversity. A riffle area was preferred, but other habitats were also sampled using a variety of techniques including kicking, jabbing, and gently rubbing hard surfaces by hand to dislodge organisms. Other habitat types, if available, included rootwads, woody debris, leaf packs, macrophytes, and undercut banks. Each jab covered one square foot, and a total of approximately 2.0 m^2 (20 square feet) of combined substrates was sampled and preserved in 70% ethanol. In the laboratory, the preserved sample was transferred to a gridded pan and organisms were picked from randomly selected grid cells until the cell that contained the 100th individual (if possible) was completely picked. Some samples had less than 100 individuals. The benthic macroinvertebrates were identified to genus, or lowest practical taxon, in the laboratory.

2.2.4 Fish

Fish were sampled during the summer index period using double-pass electrofishing of the 75-meter stream segments. Block nets were placed at each end of the segment and direct current backpack electrofishing units were used to sample the entire segment. An attempt was made to thoroughly fish each segment, sampling all available cover and habitat structures throughout the segment. A consistent effort was applied over the two passes. This sampling approach allows calculation of several metrics useful in calculating a biological index and in producing estimates of fish species abundance.

In general, a single electrofishing unit was used when the segment width was less than ten meters; two or more units were used for larger widths. Captured fish were identified to species, if possible, counted, and examined for visible external pathologies or other anomalies. Any individuals which could not be identified to species were retained for laboratory confirmation. For each pass, all individuals of each gamefish species (defined as trout, bass, walleye, pike, chain pickerel, and striped bass) were measured for total length and examined for visible external pathologies or anomalies. For each pass, all non-game species were weighed together for an aggregate biomass measurement; gamefish were also weighed in aggregate to the nearest 10 g.

After processing of the fish collection was completed in the field, voucher specimens were retained for each species not previously collected in the drainage basin, and the remaining fish were released. All voucher specimens and fish retained for positive identification in the laboratory were examined and verified by the MBSS Quality Assurance Officer or ichthyologists at Frostburg State University, Frostburg, Maryland, or the Smithsonian Institution, Washington DC.

2.2.5 Amphibians and Reptiles

At each sample segment, amphibians and reptiles were identified and the presence of observed species was recorded during the summer index period. A search of the riparian area was conducted within 5 meters of the stream on both sides of the 75-meter segment. Any amphibians and reptiles collected during the electrofishing of the stream segment were also included in the species list. Individuals were identified to species when possible. Voucher specimens and individuals not positively identifiable in the field were retained for examination and verification in the laboratory.

2.2.6 Aquatic Vegetation

During the summer index period, submerged aquatic vegetation (SAV) was sampled qualitatively by examining each 75-meter stream segment. Emergent vegetation was also recorded when encountered. Plants were identified to species and their presence recorded for each site. Species not positively identifiable in the field were retained for examination and verification in the laboratory. Due to the difficulty in long-term preservation, no permanent vouchers of SAV were retained.

2.2.7 Mussels

During the summer index period, freshwater mussels were sampled qualitatively by examining each 75-meter stream segment for the presence of mussels. Mussels were identified to species and their presence recorded. Species not positively identifiable in the field were retained for examination and verification by USGS Biological Services Division staff.

2.2.8 Physical Habitat

Habitat assessments were conducted at all stream segments as a means of assessing the importance of physical habitat to the biological integrity and fishability of freshwater streams in Maryland. Procedures for habitat assessments (Kazyak 1997) were derived from two currently used methodologies: EPA's Rapid Bioassessment Protocols (RBPs, Plafkin et al. 1989), as modified by Barbour and Stribling (1991), and the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) (Ohio EPA 1987, Rankin 1989). Guidelines and data descriptions for qualitative habitat assessment scoring are listed in Table 2-4. A number of characteristics (instream habitat, epifaunal substrate, velocity/depth diversity, pool/glide/eddy quality, riffle quality, channel alteration, bank stability,

Table 2-4. Guidelines for qualitative habitat assessment (Kazyak 1997)

MBSS Habitat Assessment Guidance Sheet				
Habitat Parameter	**Optimal 16-20**	**Sub-Optimal 11-15**	**Marginal 6-10**	**Poor 0-5**
1. Instream Habitat[(a)]	Greater than 50% mix of a variety of cobble, boulder, submerged logs, undercut banks, snags, rootwads, aquatic plants, or other stable habitat	30-50% mix of stable habitat. Adequate habitat	10-30% mix of stable habitat. Habitat availability less than desirable	Less than 10% stable habitat. Lack of habitat is obvious
2. Epifaunal Substrate[(b)]	Preferred substrate abundant, stable, and at full colonization potential (riffles well developed and dominated by cobble; and/or woody debris prevalent, not new, and not transient)	Abund. of cobble with gravel &/or boulders common; or woody debris, aquatic veg., under-cut banks, or other productive surfaces common but not prevalent /suited for full colonization	Large boulders and/or bedrock prevalent; cobble, woody debris, or other preferred surfaces uncommon	Stable substrate lacking; or particles are over 75% surrounded by fine sediment or flocculent material
3. Velocity/Depth Diversity[(c)]	Slow (<0.3 m/s), deep (>0.5 m); slow, shallow (<0.5 m); fast (>0.3 m/s), deep; fast, shallow habitats all present	Only 3 of the 4 habitat categories present	Only 2 of the 4 habitat categories present	Dominated by 1 velocity/depth category (usually pools)
4. Pool/Glide/Eddy Quality[(d)]	>50% pool/glide/eddy habitat; both deep (>.5 m)/shallows (<.2 m) present; complex cover/&/or depth >1.5 m	10-50% pool/glide/eddy habitat, with deep (>0.5 m) areas present; or >50% slow water with little cover	<10% pool/glide/eddy habitat, with shallows (<0.2 m) prevalent; slow water areas with little cover	Pool/glide/eddy habitat minimal, with max depth <0.2 m, or absent completely
5. Riffle Quality[(e)]	Riffle/run depth generally >10 cm, with maximum depth greater than 50 cm (maximum score); substrate stable (e.g. cobble, boulder) & variety of current velocities	Riffle/run depth generally 5-10 cm, variety of current velocities	Riffle/run depth generally 1-5 cm; primarily a single current velocity	Riffle/run depth < 1 cm; or riffle/run substrates concreted
6. Channel Alteration[(f)]	Little or no enlargement of islands or point bars; no evidence of channel straightening or dredging; 0-10% of stream banks artificially armored or lined	Bar formation, mostly from coarse gravel; and/or 10-40% of stream banks artificially armored or obviously channelized	Recent but moderate deposition of gravel and coarse sand on bars; and/or embankments on both banks; and/or 40-80% of banks artificially armored; or channel lined in concrete	Heavy deposits of fine material, extensive bar development; OR recent channelization or dredging evident; or over 80% of banks artificially armored
7. Bank Stability[(g)]	Upper bank stable, 0-10% of banks with erosional scars and little potential for future problems	Moderately stable. 10-30% of banks with erosional scars, mostly healed over. Slight potential in extreme floods	Moderately unstable. 30-60% of banks with erosional scars and high erosion potential during extreme high flow	Unstable. Many eroded areas. "Raw" areas frequent along straight sections and bends. Side slopes >60° common
8. Embeddedness[(h)]	Percentage that gravel, cobble, and boulder particles are surrounded by line sediment or flocculent material.			
9. Channel Flow Status[(i)]	Percentage that water fills available channel			
10. Shading[(j)]	Percentage of segment that is shaded (duration is considered in scoring). 0% = fully exposed to sunlight all day in summer; 100% = fully and densely shaded all day in summer			
11. Riparian Buffer[(k)]	Minimum width of vegetated buffer in meters; 50 meters maximum; see back of Habitat Assessment Data Sheet for buffer type and land cover immediately adjacent to buffer			

Habitat Parameter	Optimal (16-20)	Sub-Optimal (11-15)	Marginal (6-10)	Poor (0-5)
12. Aesthetic Rating[l]	Little or no evidence of human refuse present; vegetation visible from stream essentially in a natural state	Human refuse present in minor amounts; and/or channelization present but not readily apparent; and/or minor disturbance of riparian vegetation	Refuse present in moderate amounts; and/or channel-ization readily apparent; and/or moderate disturbance of riparian vegetation	Human refuse abundant and un-sightly: and/or extensive unnatural channelization; and/or nearly complete lack of vegetation
13. Remoteness[m]	Stream segment more than 1/4 mile from nearest road; access difficult and little or no evidence of human activity	Stream segment within 1/4 of but not immediately accessible to roadside access by trail; site with moderately wild character	Stream within 1/4 mile of roadside and accessible by trail; anthropogenic activities readily evident	Segment immediately adjacent to roadside access; visual , olfactory, and/or auditory displeasure experienced

a) <u>Instream Habitat</u> Rated based on perceived value of habitat to the fish community. Within each category, higher scores should be assigned to sites with a variety of habitat types and particle sizes. In addition, higher scores should be assigned to sites with a high degree of hypsographic complexity (uneven bottom). In streams where ferric hydroxide is present, instream habitat scores are not lowered unless the precipitate has changed the gross physical nature of the substrate. In streams where substrate types are favorable but flows are so low that fish are essentially precluded from using the habitat, low scores are assigned. If none of the habitat within a segment is useable by fish, a score of zero is assigned.

b) <u>Epifaunal Substrate</u> Rated based on the amount and variety of hard, stable substrates usable by benthic macroinvertebrates. Because they inhibit colonization, flocculent materials or fine sediments surrounding otherwise good substrates are assigned low scores. Scores are also reduced when substrates are less stable.

c) <u>Velocity/Depth Diversity</u> Rated based on the variety of velocity/depth regimes present at a site (slow-shallow, slow-deep, fast-shallow, and fast-deep). As with embeddedness, this metric may result in lower scores in low-gradient streams but will provide a statewide information on the physical habitat found in Maryland streams.

d) <u>Pool/Glide/Eddy Quality</u> Rated based on the variety and spatial complexity of slow- or still-water habitat within the sample segment. It should be noted that even in high-gradient segments, functionally important slow-water habitat may exist in the form of larger eddies. Within a category, higher scores are assigned to segments which have undercut banks, woody debris or other types of cover for fish.

e) <u>Riffle/Run Quality</u> Rated based on the depth, complexity, and functional importance of riffle/run habitat in the segment, with highest scores assigned to segments dominated by deeper riffle/run areas, stable substrates, and a variety of current velocities.

f) <u>Channel Alteration</u> Is a measure of large-scale changes in the shape of the stream channel. Channel alteration includes: concrete channels, artificial embankments, obvious straightening of the natural channel, rip-rap, or other structures, as well as recent bar development. Ratings for this metric are based on the presence of artificial structures as well as the existence, extent, and coarseness of point bars, side bars, and mid-channel bars which indicate the degree of flow fluctuations and substrate stability. Evidence of channelization may sometimes be seen in the form of berms whic

g) <u>Bank Stability</u> Rated based on the presence/absence of riparian vegetation and other stabilizing bank materials such as boulders and rootwads, and frequency/size of erosional areas. Sites with steep slopes are not penalized if banks are composed solely of stable materia

h) <u>Embeddedness</u> Rated as a percentage based on the fraction of surface area of larger particles that is surrounded by fine sediments on the stream bottom. In low gradient streams with substantial natural deposition, the correlation between embeddedness and fishability or ecological health may be weak or non-existent, but this metric is rated in all streams to provide similar information from all sites statewide.

i) <u>Channel Flow Status</u> Rated based on the percentage of the stream channel that has water, with subtractions made for exposed substrates and islands.

j) <u>Shading</u> Rated based on estimates of the degree and duration of shading at a site during summer, including any effects of shading caused by landforms.

k) <u>Riparian Buffer Zone</u> Based on the size and type of the vegetated riparian buffer zone at the site. Cultivated fields for agriculture which have bare soil to any extent are not considered as riparian buffers. At sites where the buffer width is variable or direct delivery of storm runoff or sediment to the stream is evident or highly likely, the smallest buffer in the segment. (e.g., 0 if parking lot runoff enters directly to the stream) is measured and recorded even though some of the segment may have a well developed buffer. In cases where the riparian zone on one side of the stream slopes <u>away</u> from the stream and there is no direct point of entry for runoff, the buffer on the other side of the stream should be measured and recorded and a comment made in comments section of the data sheet.

l) <u>Aesthetic Rating</u> Rated based on the visual appeal of the site and presence/absence of human refuse, with highest scores assigned to stream segments with no human refuse and visually outstanding character.

m) <u>Remoteness</u> Rated based on the absence of detectable human activity and difficulty in accessing the segment.

embeddedness, channel flow status, and shading) were assessed qualitatively, based on visual observations within each 75-meter sample segment. Riparian vegetation width was estimated, up to 50 m from the stream. Additional observations of the surrounding area were used to assign ratings for aesthetic value (based on visible signs of human refuse at a site), and remoteness (based on distance from the nearest road, accessibility, and evidence of human activity). Also recorded were the presence or absence of various stream features including substrate types, various morphological characteristics, beaver ponds, point sources, stream channelization, and the quantity of rootwads and other woody debris. Local land uses visible from the stream segment and riparian vegetation type were categorized.

Several additional physical characteristics were measured quantitatively to further characterize the habitat for each segment (see Kazyak 1997 for details). Quantitative measurements of the segment included maximum depth, stream gradient, thalweg depth, and wetted width. A velocity/depth profile was measured or other data collected to enable calculation of discharge.

2.3 QUALITY ASSURANCE AND QUALITY CONTROL

A Quality Assurance Officer (QAO) experienced in all aspects of the Survey was appointed to administer the quality assurance program. Specific quality assurance activities administered by the QAO included preparation of a field manual of standard sampling protocols, designing standard forms for recording field data, conducting field crew training and proficiency examinations, conducting field and laboratory audits, making independent habitat assessments, taxa identification and data validation

2.3.1 Field Sampling

To ensure consistent implementation of sampling procedures and a high level of technical competency, experienced field biologists were assigned to each crew and all field personnel completed program training before participating in the 1995-1997 MBSS. Training topics included MBSS program orientation, stream segment location using global positioning system (GPS) equipment, sampling protocols, operation and maintenance of sampling equipment, data transcription, quality assurance/quality control, and safety. The spring field crew received additional training in sampling protocols for water quality and benthic macroinvertebrates. The summer field crews received additional training in habitat assessment methods, fish taxonomy, and *in situ* water chemistry assessment.

Training included classroom, laboratory, and field activities. Instructors emphasized the objectives of MBSS and the importance of strict adherence to the sampling protocols. The QAO conducted proficiency examinations to evaluate the effectiveness of the training program and ensure that the participants had detailed knowledge of the sampling protocols. Members of the spring sampling crew were required to demonstrate proficiency in techniques for collecting samples for water chemistry and benthic macroinvertebrates. At least one member of the summer sampling crew was required to pass a comprehensive fish taxonomy examination. Each crew had to demonstrate proficiency in locating pre-selected stream segments using the GPS receiver and determining if the segment was acceptable for sampling. Comprehensive "dry runs" were conducted to simulate actual field conditions and evaluate classroom instruction.

Field audits were conducted by the QAO during the field sampling to assess the adequacy of training, adherence to sampling protocols, and accuracy of data transcription. The audits included evaluation of the preparation and planning prior to field sampling, stream segment location using GPS equipment and assessment of acceptability for sampling, adherence to sampling protocols, data transcription, and equipment maintenance and calibration. The QAO made an independent assessment of habitat at all segments where field audits were done, approximately 10% of the total number of sites.

At the end of each sampling year, specimens of all taxa collected were verified by an appropriate recognized authority in fish, benthic macroinvertebrate, reptile and amphibian, plant, or mussel taxonomy. For benthic macroinvertebrates, a random subset of at least 5% of the preserved benthic samples was independently reprocessed in the laboratory to verify identifications.

2.3.2 Data Management

All crews used standardized pre-printed data forms developed for the Survey to ensure that all data required for a sampling segment were recorded and standard units of measure were used (Kazyak 1997). Using standard data forms facilitated developing data-entry protocols and minimized transcription error. The field crew leader and a second reviewer checked all data sheets for completeness and legibility before leaving each sampling location. Original data sheets were sent to the Data Management Officer for data entry, while copies were retained by the field crews.

A custom database application, in which the input module was designed to match each of the field data sheets used in the 1995-1997 sampling effort was used for data entry. Whenever possible, QA/QC checks were embedded into data entry screens. Data were independently entered into two databases that were compared as a quality-control procedure. Differences between the two databases were resolved from original data sheets or through discussions with field crew leaders.

2.4 LANDSCAPE ANALYSIS

Land uses within watersheds upstream of sample sites were derived with a geographic information system (GIS), using Micro Images (MIPS) and PC Arc Info software. Watersheds upstream of each sample site were digitized using topographic lines from digital county topographic maps (1:62,500 scale). Watersheds were digitized in TNT MIPS and exported to PC Arc Info. The watershed file was then intersected with land use/land cover information from the Federal Region III Multi-Resolution Land Characterization (MRLC) digital data set, Version 2 (MRLC 1996a, 1996b). The MRLC was developed by a federal agency consortium, using data primarily from Landsat 1991-1993 Thematic Mapper satellite images at a resolution of 30 x 30 m pixels. The MRLC classifies land cover into fifteen categories (Table 2-5). Using GIS, the area within each watershed was calculated, as was the percentage of area within each watershed represented by each type of land use. For some analyses, land uses were collapsed to the following six classes: water, urban land, agriculture, forest (including woody wetlands), emergent wetlands, and barren. Because they represent minimal amounts of land cover in the areas of concern, the barren classes of quarries and beach areas were not encountered in the 1995-1997 MBSS data set.

Table 2-5. Land cover classes in the Multi-Resolution Land Characterization data set for Region III (MRLC Version 2)

Water	
Developed Areas	
	Low Intensity Developed
	High Intensity Developed
Cultivated Areas	
	Hay/pasture/grass
	Row crops
	Probable row crops
Natural Vegetated Areas	
	Conifer (Evergreen) Forest
	Mixed Forest
	Deciduous Forest
	Woody Wetlands
	Emergent Wetlands
Barren Areas	
	Quarries
	Coal Mines
	Beach Areas
	Transitional

2.5 INDICATOR DEVELOPMENT

2.5.1 Fish and Benthic IBIs

Fish and benthic IBI scores for the 1995-1997 MBSS were determined by comparing the fish or benthic assemblage at each site to those found at minimally impacted reference sites (see Roth et al. 1998a and Stribling et al. 1998). Three separate formulations were employed for the fish IBI, one for each of three distinct geographic areas: Coastal Plain, Eastern Piedmont, and Highland. The two formulations used for the benthic IBI cover the Coastal Plain and non-Coastal Plain regions. Individual metrics for the IBI were scored 1, 3, or 5, based on comparison with the distribution of metric values at reference sites (see Tables 2-6 and 2-7). Final MBSS IBI scores were calculated as the mean of the individual metric scores and therefore range from 1 to 5. Table 2-8 contains more detailed descriptions for each of the IBI categories developed.

2.5.2 The Hilsenhoff Biotic Index and the Number of EPT Taxa

The Hilsenhoff Biotic Index evaluates the pollution tolerance of benthic macroinvertebrate organisms, especially their tolerance to organic pollution. Hilsenhoff scores tend to increase with increased degradation. A tolerance value of 0 to 10 is assigned to each taxon collected; the Index is calculated as an average tolerance value for the assemblage, weighted by the abundance of each taxon. Primarily, tolerance values for Maryland benthic taxa are derived from research in the Midwest (Hilsenhoff 1987), New York (Bode 1988), and North Carolina (Lenat 1993). The original Hilsenhoff scale contained threshold values for six categories of degradation. Bode and Novak (1995) modified this scale to include four categories ranging from non-impacted to severely impacted. For the 1995-1997 MBSS, these four categories were adopted with narrative ratings assigned as follows:

- Scores of 0 to 4.5 are rated good
- Scores of 4.51 to 6.5 are rated fair
- Scores of 6.51 to 8.5 are rated poor
- Scores of 8.51 to 10.0 are rated very poor

Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness is also a commonly used measure of benthic community condition. EPT taxa are generally intolerant of poor water quality and the number of EPT taxa has been widely used in benthic assessments (Plafkin et al. 1989).

Table 2-6. Metrics and scoring criteria for the recommended final fish IBI. Some metrics[a] were adjusted for watershed area, based on linear relationships between the metric and log(watershed area)[b] in acres

	Scoring criteria		
	5	**3**	**1**
Coastal Plain			
Number of native species[a]	Criteria vary with stream size (see below)		
Number of benthic fish species[a]	Criteria vary with stream size (see below)		
Number of intolerant species[a]	Criteria vary with stream size (see below)		
Percent tolerant fish	≤ 50	$50 < x \leq 93$	> 93
Percent abundance of dominant species	≤ 33	$33 < x \leq 78$	> 78
Percent generalists, omnivores, and invertivores	≤ 92	$92 < x < 100$	100
Number of individuals per square meter	≥ 0.79	$0.42 \leq 0.79$	< 0.42
Biomass (g) per square meter	≥ 9.9	$3.6 \leq 9.9$	< 3.6
Eastern Piedmont			
Number of native species[a]	Criteria vary with stream size (see below)		
Number of benthic fish species[a]	Criteria vary with stream size (see below)		
Number of intolerant species[a]	Criteria vary with stream size (see below)		
Percent tolerant fish	≤ 41	$41 < x \leq 65$	> 65
Percent abundance of dominant species	≤ 30	$30 < x \leq 52$	> 52
Percent generalists, omnivores, and invertivores	≤ 86	$86 < x \leq 99.7$	> 99.7
Number of individuals per square meter	≥ 0.81	$0.35 \leq 0.81$	< 0.35
Biomass per square meter	≥ 8.0	$3.7 \leq 8.0$	< 3.7
Percent lithophilic spawners	≥ 62	$22 \leq 62$	< 22
Highland			
Number of benthic fish species[a]	Criteria vary with stream size (see below)		
Number of intolerant species[a]	Criteria vary with stream size (see below)		
Percent tolerant fish	≤ 28	$28 < x \leq 71$	> 71
Percent abundance of dominant species	≤ 49	$49 < x \leq 91$	> 91
Percent generalists, omnivores, and invertivores	≤ 49	$49 < x \leq 92$	> 92
Percent insectivores	≥ 48	$8 \leq 48$	< 8
Percent lithophilic spawners	≥ 70	$42 \leq 70$	< 42

Table 2-6. Cont'd

[(a)] Adjusted value = observed value/expected value, where expected value = m * log(watershed area in acres) + b.

	Scoring criteria 5	3	1
Coastal Plain			
Number of native species - Adjusted value	≥ 1.06	0.53 < x ≤ 1.06	< 0.53
Number of benthic fish species - Adjusted value	≥ 1.06	0 < x < 1.06	0
Number of intolerant species Adjusted value	≥ 0.34	0 < x < 0.34	0
Eastern Piedmont			
Number of native species - Adjusted value	≥ 1.02	0.56 < x ≤ 1.02	< 0.56
Number of benthic fish species - Adjusted value	≥ 0.99	0.50 < x ≤ 0.99	< 0.50
Number of intolerant species Adjusted value	≥ 0.59	0.18 < x ≤ 0.59	< 0.18
Highland			
Number of benthic fish species - Adjusted value	≥ 1.03	0.33 < x ≤ 1.03	< 0.33
Number of intolerant species Adjusted value	≥ 0.73	0.23 < x ≤ 0.73	< 0.23

[(b)] Slope and intercept values for selected metrics, based on linear regression relationships between metric and log(watershed area) in acres

	slope (m)	intercept(b)
Coastal Plain		
Number of native species	6.5936	-13.0055
Number of benthic fish species	1.5743	-3.929
Number of intolerant species	2.1485	- 5.286
Eastern Piedmont		
Number of native species	5.5701	-8.1135
Number of benthic fish species	13245	-2.6437
Number of intolerant species	4.4502	-8.8991
Highland		
Number of benthic fish species	1.6067	-3.5202
Number of intolerant species	3.0723	-7.3029

Table 2-7. Metrics and scoring criteria for the benthic IBI. From Stribling et al. 1998.

	Scoring Criteria		
	5	**3**	**1**
Coastal Plain			
Total taxa	>24	11<x<24	<11
EPT taxa	6	3<x<6	<3
% Ephemeroptera	>11.4	2.0<x< 11.4	<2.0
% Tanytarsini of Chiron.	>13.0	0.0<x<13.0	<0.0
Maryland Index	>12	4<x<12	<4
Scraper taxa	>4	1<x< 4	<1
% clingers	>62.1	38.7<x< 62.1	<38.7
Non-Coastal Plain			
Total taxa	>22	16<x<22	<16
EPT taxa	>12	5<x<12	<5
Ephemeroptera taxa	>4	2<x<4	<2
Diptera taxa	>9	6<x< 9	<6
% Ephemeroptera	>20.3	5.7<x<20.3	<5.7
% Tanytarsini	>4.8	0.0<x<4.8	<0.0
Intolerant taxa	>8	3<x<8	<3
% tolerant	<11.8	11.8<x< 48.0	>48.0
% collectors	>31.0	13.5<x<31.0	<13.5

Table 2-8. Narrative descriptions of stream biological integrity associated with each of the IBI categories

Good	IBI score 4.0 - 5.0	Comparable to reference streams considered to be minimally impacted. Fall within the upper 50% of reference site conditions.
Fair	IBI score 3.0 - 3.9	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of these minimally impacted streams. Fall within the lower portion of the range of reference sites (10th to 50th percentile).
Poor	IBI score 2.0 - 2.9	Significant deviation from reference conditions, with many aspects of biological integrity not resembling the qualities of these minimally impacted streams, indicating some degradation.
Very Poor	IBI score 1.0 - 1.9	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of these minimally impacted streams, indicating severe degradation.

2.5.3 The Physical Habitat Index

The Physical Habitat Index (PHI; Hall and Morgan 1999) developed for the 1995-1997 MBSS was based on evaluating the relative importance (discriminatory power) of individual metrics and combinations of metrics for explaining natural differences in Maryland streams. Separate PHIs were developed for each of two geographic stratum: Coastal Plain and non-Coastal Plain. Reference sites were determined using the same criteria applied for the fish and benthic IBIs. Four individual physical habitat metrics were determined to be important in discriminating reference sites from degraded sites for both the Coastal Plain and non-Coastal Plain: instream habitat structure, velocity/depth diversity, embeddedness, and aesthetic quality. In the Coastal Plain, two additional variables were used: pool/glide/eddy quality and maximum depth. In the non-Coastal Plain, riffle/run quality and the number of rootwads in each stream reach were used as additional components of the PHI. An average of these values was taken (after the values were relativized to approximately the same scale). The numbers were then adjusted to a centile scale that rated each sample segment as follows:

- Scores of 72 to 100 are rated good
- Scores of 42 to 71.9 are rated fair
- Scores of 12 to 41.9 are rated poor
- Scores of 0 to 11.9 are rated very poor

3 DATA BASE INFORMATION

3.1 GUIDE TO THE DATA SETS

MBSS 1995-1997 data are contained within five data sets as listed in Table 3-1. This chapter describes the contents of each data set. Data sets are comma-delimited ASCII files.

With the exception of the BENT3YR data set (which is too large to be viewed in most spreadsheets), locational, water chemistry, physical habitat, land use, and indicator data are included with each data set. These data will aid in the sorting of species information by a particular location or other sampled parameter.

Table 3-1. Index to 1995-1997 MBSS data sets

Data	Name of Data Set	File Size	Location in Data Guide
1. Locational, water chemistry, habitat, land use, and indicator data 2. Number of fish species 2. Biomass of game and nongame fish species 4. Percent of fish with anomalies 5. Abundance of individual species	FISH3YR	542 KB	Section 3.2 Section 3.3
1. Locational, water chemistry, habitat, land use, and indicator data 2. Number of amphibian and reptile species 3. Presence/absence information for individual species	HERP3YR	450 KB	Section 3.2 Section 3.4
2. Locational, water chemistry, habitat, land use, and indicator data 2. Number of plant species 3. Presence/absence information for individual species	PLNT3YR	408 KB	Section 3.2 Section 3.5

Table 3-1. Continued			
Data	**Name of Data Set**	**File Size**	**Location in Data Guide**
1. Locational, water chemistry, habitat, land use, and indicator data 2. Number of mussel species 3. Presence/absence information for individual species	MUSS3YR	375 KB	Section 3.2 Section 3.6
1. Locational information 2. Benthic macroinvertebrate taxa name 3. Number of individuals found 4. Number of grids in which taxon was found	BENT3YR	1.4 MB	Section 3.7

3.2 LOCATIONAL, WATER CHEMISTRY, PHYSICAL HABITAT, LAND USE, AND INDICATOR DATA

These data contain information describing the location of each site at which samples were collected. Also included are water chemistry, physical habitat, land use, and indicator data for each site. This information is included in four of the data sets described here: FISH3YR, HERP3YR, PLNT3YR, and MUSS3YR. Each record in these data sets refer to one site, with the information in the tables below listed as separate variables.

3.2.1 Locational Information

A list of variables concerning the location of each 1995-1997 MBSS sample site is located in Table 3-2.

3.2.1.1 Site Identification (SITE)

Within each sampling year, each sample segment is identified by a unique identification code (Table 3-2). The variable SITE is used in each of the other MBSS data sets to identify the sample segment at which data were collected.

Table 3-2. Locational information common to the data sets FISH3YR, HERP3YR, PLNT3YR, and MUSS3YR (See Section 3.2.1 for detailed descriptions)

Variable	Type	Label
SITE	Char	Site Identification
ST_NAME	Char	Stream Name
YEAR	Num	Year Sampled
REGION	Char	Geographic Region
PHYSIO	Char	Physiographic Province
COUNTY	Char	County
BASIN	Char	Basin
SEGMENT	Num	Sample Segment
ORDER	Num	Strahler Order
SAMP_SPR	Char	Spring Sampleability
DATE_SPR	Num	Actual Date Sampled - Spring
SAMP_SUM	Char	Summer Sampleability
DATE_SUM	Num	Actual Date Sampled - Summer
LAT	Num	Latitude
LONG	Num	Longitude
NORTHING	Num	MD Plane Coordinate
EASTING	Num	MD Plane Coordinate
SHEDCODE	Num	Maryland 8-digit Watershed Code
SHEDNAME	Char	Maryland Watershed Name

1995-1997 SITE identifiers are 14-character codes made up of five parts: COUNTY-PHYSIO-reach i.d.-SEGMENT-YEAR. For 1995-1997 MBSS sites, the 3-digit segment code is a unique identifier for a segment within the basin and year, with the first digit signifying stream order.

Example: 1995 site CH-S-062-314-95 is located on a stream reach in Charles County (CH), within the Southern Coastal Plain physiographic province (S) and stream reach CH-S-062. The segment code 314 is a unique identifier for this site within the basin and also signifies the site is located on a third order stream.

3.2.1.2 Stream Name (ST_NAME)

The name of the stream in which the sample site is located (Table 3-2). Unnamed tributaries were labeled consecutively from the upstream portion of the stream and are designated as UT1, UT2, etc.

3.2.1.3 Year (YEAR)

The year that the site was sampled (Table 3-2).

3.2.1.4 Geographic Region (REGION)

The variable REGION specifies one of 3 geographic regions within the state of Maryland. A one-letter code for the variable REGION specifies whether a site is located within West (W), Central (C), or East (E) Maryland (Table 3-2). The 17 Maryland basins sampled by the MBSS were divided among these 3 regions to most efficiently assign sites to the sampling teams from each region (Figure 2-1).

3.2.1.5 Physiographic Province (PHYSIO)

The variable PHYSIO (Table 3-2) specifies one of six physiographic provinces within the state of Maryland (Figure 3-1). One-letter codes for the variable PHYSIO are given in Table 3-3. The PHYSIO code is included as the second part of the SITE code.

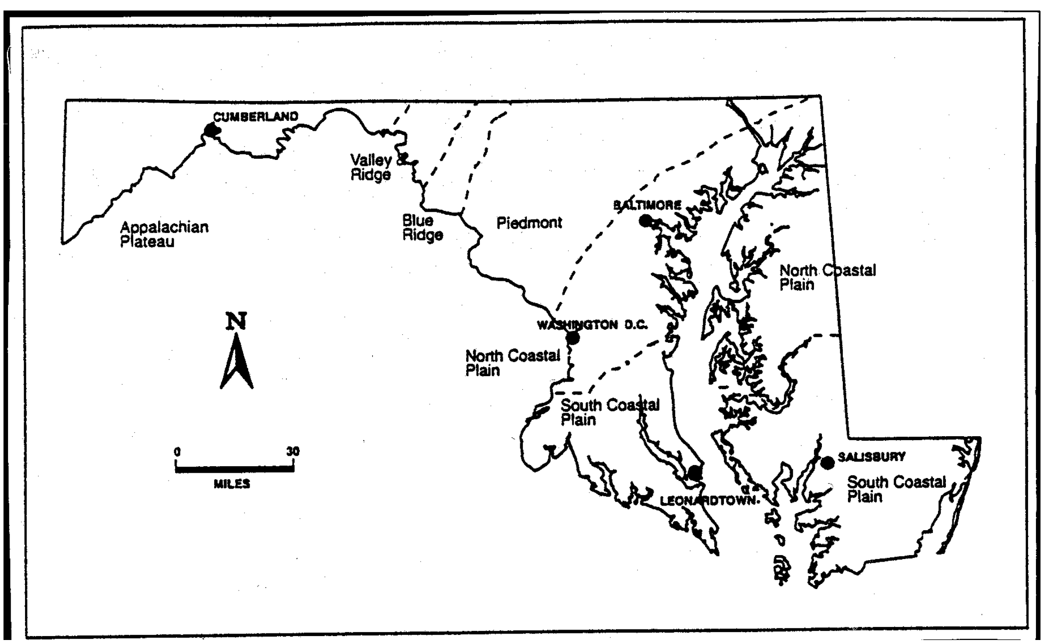


Figure 3-1. Physiographic provinces of Maryland

Table 3-3. Entries for physiographic province, represented by the variable PHYSIO

Physiographic Province	Code
Appalachian Plateau	A
Blue Ridge	B
North Coastal Plain	N
Piedmont	P
South Coastal Plain	S
Valley and Ridge	V

3.2.1.6 County (COUNTY)

The variable COUNTY (Table 3-2) specifies one of 24 counties within the state of Maryland, as designated by political boundaries. Two-letter codes for the variable COUNTY are given in Table 3-4.

At several sites throughout the state, a new county designation was made. This is because the identification of the stream reach (and therefore the SITE name) uses the county where the reach originates. In some cases, the actual location of the study site is in a different county than the reach origin. Each site was examined for this condition using GIS data and the data provided here under COUNTY reflect the correct county location for the actual site.

Table 3-4. Entries for the variable COUNTY

County	Code
Allegany	AL
Anne Arundel	AA
Baltimore City	BC
Baltimore	BA
Calvert	CA
Caroline	CN
Carroll	CR

Table 3-4. Cont'd

County	Code
Cecil	CE
Charles	CH
Dorchester	DO
Frederick	FR
Garrett	GA
Harford	HA
Howard	HO
Kent	KE
Montgomery	MO
Prince George's	PG
Queen Anne's	QA
St. Mary's	SM
Somerset	SO
Talbot	TA
Washington	WA
Wicomico	WI
Worcester	WO

3.2.1.7 Drainage Basin (BASIN)

Sampling sites for the MBSS were located in 17 distinct drainage basins (Figure 2-1). A basin is specified by a two-letter code (Table 3-2). Entries for the variable BASIN are given in Table 3-5.

3.2.1.8 Sample Segment (SEGMENT)

Each 1995-1997 MBSS sample site was a 75-meter long stream segment. The variable SEGMENT (Table 3-2) identifies each sample site and is included in the SITE code.

Table 3-5. 1995-1997 MBSS drainage basins, represented by the variable BASIN

Drainage Basin Name	Code
Bush River	BU
Choptank River	CK
Chester River	CR
Elk River	EL
Gunpowder River	GU
Lower Potomac River	LP
Middle Potomac River	MP
North Branch Potomac River	NO
Nanticoke/Wicomico Rivers	NW
Pocomoke River	PC
Patapsco River	PP
Potomac Washington Metro	PW
Patuxent River	PX
Lower Susquehanna River	SQ
Upper Potomac River	UP
West Chesapeake	WC
Youghiogheny River	YG

3.2.1.9 **Stream Order (ORDER)**

The variable ORDER (Table 3-2) represents stream order. The Strahler convention (Strahler 1957) was used for ranking stream reaches by order; first order reaches, for example, are the most upstream reaches in the branching stream system. Site selection and stream order determinations were based on a stream reach file digitized from 1:250,000 scale topographic maps for the MSSCS in 1987. In some cases, stream order determined using this method may differ from stream order determined from a 1:24,000 scale topographic map.

3.2.1.10 Spring Sampleability (SAMP_SPR)

Spring sampleability (Table 3-2) indicates whether or not a preselected site was able to be sampled during the spring index period. Sampleability is indicated by a yes (Y) or no (N).

3.2.1.11 Actual Date Sampled - Spring (DATE_SPR)

The date sampling occurred at a site during the spring index period (Table 3-2).

3.2.1.12 Summer Sampleability (SAMP_SUM)

Summer sampleability (Table 3-2) indicates whether or not a preselected site was able to be sampled during the summer index period. Sampleability is indicated by a yes (Y) or no (N).

3.2.1.13 Actual Date Sampled - Summer (DATE_SUM)

The date sampling occurred at a site during the summer index period (Table 3-2), if the site was sampled during the summer (SAMP_SUM = "Y").

3.2.1.14 Latitude and Longitude (LAT, LONG)

The location of the sample site is specified using a pair of geographic coordinates, latitude (LAT) and longitude (LONG) (Table 3-2). LAT and LONG, given in positive decimal degrees, refer to the location on the 1:250,000 base map (NAD27) used for sample selection. Maps of this scale are accurate to approximately 200 m.

3.2.1.15 Maryland State Plane Coordinates (NORTHING, EASTING)

Using the Maryland State Plane Coordinate System, the geographic location of the sample site is specified using a pair of coordinates (NORTHING and EASTING; Table 3-2). MBSS Maryland State Plane Coordinates are based on the North American Datum of 1927, the basis of the 1939 Maryland Coordinate System (state plane 27 feet). A site's location is designated by the distance north (NORTHING) and east (EASTING) of an imaginary point of origin, fixed at a point southwest of the state. NORTHING and EASTING are given in feet.

3.2.1.16 Maryland 8-digit Watershed Code (SHEDCODE)

This code identifies the watershed where the site is located (Table 3-2). SHEDCODE refers to the 8-digit code assigned to each watershed by the Maryland Department of the Environment (MDE) and DNR. There are 138 of these state-designated watersheds in Maryland.

3.2.1.17 Maryland Watershed Name (SHEDNAME)

This is the name assigned to each 8-digit watershed by MDE and DNR (Table 3-2).

3.2.2 Water Chemistry

A list of variables concerning water chemistry information at each 1995-1997 MBSS site is located in Table 3-6.

Table 3-6. 1995-1997 MBSS water chemistry information common to the data sets FISH3YR, HERP3YR, PLNT3YR, and MUSS3YR

Variable	Type	Label
TEMP_FLD	Num	Water Temperature (°C)
DO_FLD	Num	Dissolved Oxygen (mg/l)
PH_LAB	Num	Lab pH
PH_FLD	Num	In-situ pH
COND_LAB	Num	Lab Conductance (µmho/cm)
COND_FLD	Num	In-situ Conductance (µmho/cm)
ANC_LAB	Num	Acid Neutralizing Capacity (µeq/l)
DOC_LAB	Num	Dissolved Organic Carbon (mg/l)
NO3_LAB	Num	Nitrate Nitrogen (mg/l)
SO4_LAB	Num	Sulfate (mg/l)
ACIDSRC	Char	Source of Acidity

3.2.2.1 Temperature (TEMP_FLD)

Temperature is given in °C (degrees Celsius; Table 3-6).

3.2.2.2 Dissolved Oxygen (DO_FLD)

Dissolved oxygen is given in ppm (parts per million; Table 3-6).

3.2.2.3 Spring and Summer pH (PH_LAB and PH_FLD)

The spring pH (pH_LAB) and the *in situ* summer pH (PH_FLD) are given in standard pH units (Table 3-6).

3.2.2.4 Spring and Summer Conductance (COND_LAB and COND_FLD)

Conductance in both the spring (COND_LAB) and summer (COND_FLD) is given in µmho/cm (Table 3-6).

3.2.2.5 ANC (ANC_LAB)

Acid neutralizing capacity is given in µeq/L (Table 3-6).

3.2.2.6 Sulfate (SO_4_LAB), Nitrate-Nitrogen (NO_3_LAB), and Dissolved Organic Carbon (DOC_LAB)

Sulfate, nitrate nitrogen, and dissolved organic carbon concentrations are given as mg/L (Table 3-6).

3.2.2.7 Acid Source (ACIDSRC)

This variable (Table 3-6) was derived from water chemistry and land use data collected during 1995-1997 MBSS sampling (for more information, see Roth et. al 1999). Table 3-7 contains a list of the codes for the possible sources of acidity.

Table 3-7. Acid source codes for 1995-1997 MBSS sample sites	
Acid Source	**Code**
None	None
Possible Agriculture Influence	AG
Dominated by Acid Mine Drainage (AMD)	AMD
Acidic Deposition	AD
Dominated by Organic Sources	ORG
Mixed Influence of AMD and Acidic Deposition	AMD + AD
Mixed Influence of Organic Sources and Acidic Deposition	ORG + AD

3.2.3 Physical Habitat

A list of the variables concerning physical habitat characteristics of each 1995-1997 MBSS site is included in Table 3-8.

Table 3-8. 1995-1997 MBSS physical habitat information common to the data sets FISH3YR, HERP3YR, PLNT3YR, and MUSS3YR

Variable	Type	Label
PASTURE	Char	Pasture
CHANNEL	Char	Channelized
CONCRETE	Char	Concrete/Gabion
STORMDRN	Char	Storm Drain
EFF_DIS	Char	Effluent Discharge
BEAVPOND	Char	Beaver Pond
INSTRHAB	Num	Instream Habitat Structure
EPI_SUB	Num	Epifaunal Substrate
VEL_DPTH	Num	Velocity/Depth Diversity
POOLQUAL	Num	Pool/Glide/Eddy Quality
RIFFQUAL	Num	Riffle/Run Quality

Table 3-8. Cont'd		
Variable	**Type**	**Label**
CHAN_ALT	Num	Channel Alteration
BANKSTAB	Num	Bank Stability
EMBEDDED	Num	Embeddedness
CH_FLOW	Num	Channel Flow Status
SHADING	Num	Shading
REMOTE	Num	Remoteness
AESTHET	Num	Aesthetic Rating
WOOD_DEB	Num	Number of Woody Debris
NUMROOT	Num	Number of Rootwads
RIP_WID	Num	Riparian Buffer Width (m)
BUFF_TYP	Char	Riparian Buffer Type
ADJ_COVR	Char	Adjacent Land Cover Type
MAXDEPTH	Num	Maximum Depth (cm)
ST_GRAD	Num	Stream Gradient (%)
AVGWID	Num	Average Wetted Width (m)
AVGTHAL	Num	Average Thalweg Depth (cm)
AVG_VEL	Num	Average Velocity (m/s)
FLOW	Num	Streamflow (cfs)

3.2.3.1 Stream Character Categories

Stream features present within the 75-meter sampling segment were recorded.. Features included are considered functionally important for stream health and are: pasture, channelization, concrete, storm drains, effluent discharge, and beaver ponds. Each stream character feature is included in the data set as a separate variable, with an entry of "X" indicating the presence of that stream character feature. Variables included are listed in Table 3-8.

3.2.3.2 Habitat Assessment Scores or Percentages

Following the MBSS Habitat Assessment Guidance Sheet (Table 2-4), scores or percentages were assigned for each of the 13 parameters describing the instream habitat, riparian buffer, and general site surroundings. For most parameters, assessment was based on observation of the entire 75-m segment and adjacent riparian buffer. Aesthetic rating and remoteness values described the general vicinity of the sample segment. Variables included are listed in Table 3-8.

3.2.3.3 Woody Debris (WOOD_DEB) and Number of Rootwads (NUMROOT)

The number of pieces of woody debris (WOOD_DEB) and the number of rootwads (NUMROOT) at each site were recorded (Table 3-8).

3.2.3.4 Riparian Width (RIP_WID), Buffer Type (BUFF_TYP), and Adjacent Land Cover (ADJ_COVR)

The width of the vegetated riparian buffer (RIP_WID) was estimated in meters, to a maximum of 50 m (Table 3-8). If the buffer was greater than or equal to 50 m, a value of 50 was entered. This measure is the width of the vegetated riparian buffer on the side of the stream with the smallest buffer. The dominant type of riparian buffer (BUFF_TYP) and the dominant type of land cover adjacent to the buffer (ADJ_COVR) are described by one of the sixteen land cover codes (Table 3-9).

3.2.3.5 Maximum Depth (MAXDEPTH)

Maximum stream depth (MAXDEPTH) within the 75-meter segment is given in centimeters (Table 3-8).

3.2.3.6 Stream Gradient (ST_GRAD)

Stream gradient was measured from the downstream boundary (0 meter point) to the upstream boundary of a segment (75 meter point) using an inclinometer to measure the water surface slope. Stream gradient (ST_GRAD) is given as percent slope (Table 3-8).

Table 3-9. Entries for Riparian Buffer Zone type (BUFF_TYP) and Adjacent Land Cover type (ADJ_COVR) in the 1995-1997 MBSS data sets

Land Cover Type	Code
Forest	FR
Old Field	OF
Emergent Vegetation	EM
Mowed Lawn	LN
Tall Grass	TG
Logged Area	LO
Bare Soil	SL
Railroad	RR
Paved Road	PV
Parking Lot/Industrial/Commercial	PK
Gravel Road	GR
Dirt Road	DI
Pasture	PA
Orchard	OR
Cropland	CP
Housing	HO

3.2.3.7 Average Width (AVGWID)

The wetted width of the stream, in meters, was measured at the 0, 25, 50, and 75 meter points of the sample segment. The average of these measures (AVGWID), presented in meters, is included in the 1995-1997 MBSS data sets (Table 3-8).

3.2.3.8 Average Thalweg Depth (AVGTHAL)

Thalweg depth, the deepest portion of the lateral transect of the stream, was measured in centimeters at the 0, 25, 50, and 75 meter points of the sample segment. The average of these measures (AVGTHAL), presented in centimeters, is included in the 1995-1997 MBSS data sets (Table 3-8).

3.2.3.9 Average Velocity (AVG_VEL)

Thalweg velocity was measured with a flowmeter at the deepest portion of the lateral transect at the 0, 25, 50, and 75 meter points of the sample segment. Average thalweg velocity (AVG_VEL), presented in meters per second, is included in the 1995-1997 MBSS data sets (Table 3-8).

3.2.3.10 Flow (FLOW)

Discharge (streamflow), represented by the variable FLOW, is reported in the data set in units of cubic feet per second (cfs; Table 3-8). Discharge was calculated from raw data collected at each stream segment from a site visit during the summer sampling period.

At most sites, a standard transect method was employed. The field crew constructed a velocity/depth provide of the segment using a current meter to measure stream velocity and recording stream depth at 5 to 20 regular intervals across the stream. At each location along the transect, velocity was measured at a point 0.6 of the distance from the water surface to the bottom. Calculation of discharge from raw velocity, depth, and lateral location data followed standard procedures as described by Buchanan and Somers (undated).

At other sites, where flows were too low to be measured with a current meter, an alternative method was used. Flow was constricted as much as possible in a 1 meter section of uniform width, and the speed of a floated object was determined. The depth, width, and time (three trials) for a floated object to move 1 m were recorded and used to calculate discharge.

3.2.4 Land Use

A list of the variables concerning land use characteristics of each 1995-1997 MBSS site is included in Table 3-10.

3.2.4.1 Catchment Area (ACREAGE)

The catchment area, given in acres (Table 3-10).

Table 3-10. 1995-1997 MBSS land use information common to the data sets FISH3YR, HERP3YR, PLNT3YR, and MUSS3YR

Variable	Type	Label
ACREAGE	Num	Catchment Area (acres)
URBAN	Num	Urban Land Use (%)
AGRI	Num	Agricultural Land Use (%)
FOREST	Num	Forest Land Use (%)
WETLANDS	Num	Wetland Land Use (%)
BARREN	Num	Barren Land Use (%)
WATER	Num	Water Land Use (%)
HIGHURB	Num	High Intensity Urban Land Use (%)
LOWURB	Num	Low Intensity Urban Land Use (%)
PASTUR	Num	Hay/pasture/grass Land Use (%)
PROBCROP	Num	Probable Row Crop Land Use (%)
ROWCROP	Num	Row Crop Land Use (%)
CONIFER	Num	Conifer (Evergreen) Forest Land Use (%)
DECIDFOR	Num	Deciduous Forest Land Use (%)
MIXEDFOR	Num	Mixed Forest Land Use (%)
EMERGWET	Num	Emergent Wetlands Land Use (%)
WOODYWET	Num	Woody Wetland Land Use (%)
COALMINE	Num	Coal Mine (%)
TRANS	Num	Transitional Land Use (%)

3.2.4.2 Land Use Characterizations

Land use characterizations (Table 3-10) were based on the 1996 MRLC land cover data base for Region III (MRLC 1996a, 1996b). Table 3-11 presents the classifications used and a short description of each. Classes include the individual MRLC classes (e.g., low intensity urban and coniferous forest) and aggregated classes (e.g., urban, forest).

Table 3-11. Land use classifications used in the 1995-1997 MBSS data sets		
Land Use	**Description**	**Code**
Urban	Characterized by a high percentage of construction materials	URBAN
Agriculture	Vegetation which has been planted and/or managed by humans	AGRI
Forest	Upland areas dominated by trees	FOREST
Wetlands	Non-woody or woody vegetation where the soil is periodically saturated with water	WETLANDS
Barren	Bare rock, sand, silt, gravel, etc with little or no vegetation	BARREN
Water	Open water	WATER
High Intensity Urban	Heavily built up urban centers with very little vegetation and high population densities	HIGHURB
Low Intensity Urban	Land areas with a mixture of constructed materials and vegetation	LOWURB
Pasture	Dominated by grasses planted for livestock grazing or the production of hay crops	PASTUR
Probable Row Crops	Indeterminate areas of agriculture, but probably planted with row crops	PROBCROP
Row Crops	Agricultural areas used for the production of crops	ROWCROP
Coniferous Forest	Areas dominated by tree species that maintain their leaves all year	CONIFER
Deciduous Forest	Areas dominated by tree species that their foliage during some part of the year	DECIDFOR
Mixed Forest	Forest areas dominated by neither coniferous or deciduous tree species	MIXEDFOR
Emergent Wetlands	Non-woody wetland areas	EMERGWET
Woody Wetlands	Forested or shrubby wetland areas	WOODYWET
Coal Mines	Areas with obvious evidence of coal mines	COALMINE
Transitional Areas	Areas changing from one land cover to another	TRANS

3.2.5 Indicators

A list of variables concerning the indicators developed for the 1995-1997 MBSS is included in Table 3-12.

Table 3-12. Information concerning the indicators developed for the 1995-1997 MBSS common to the data sets FISH3YR, HERP3YR, PLNT3YR, MUSS3YR

Variable	Type	Label
PHI	Num	Physical Habitat Index
BKTRFLAG	Num	Brook Trout Abundance
BLACKWAT	Num	Blackwater Stream
STRATA_R	Char	Fish IBI Stratum
FIBI_98	Num	Fish Index of Biotic Integrity
BIBI_98	Num	Benthic Index of Biotic Integrity
HILSNHOF	Num	Hilsenhoff Index of Biotic Integrity
EPT_TAXA	Num	Number of EPT Taxa

3.2.5.1 Physical Habitat Index (PHI)

The Physical Habitat Index (PHI) is a quantitative rating of the physical habitat at each site (see Section 2.5.3 and Table 3-12). Scores range from 0 (very poor) to 100 (good).

3.2.5.2 Presence of Brook Trout (BKTRFLAG)

Indicates whether brook trout were captured at a site (Table 3-12). Since brook trout are a coldwater species, this flag may help identify whether the site is located in a coldwater stream. A value of “1" indicates that this species was found, while a value of “0" indicates that it was not.

3.2.5.3 Blackwater Stream (BLACKWAT)

Indicates that the site is located in a blackwater stream (Table 3-12). A value of “1" indicates that the site is blackwater, while a value of “0" indicates that it is not.

3.2.5.4 Fish IBI Stratum (STRATA_R)

The physiographic stratum assigned to each site to determine which of three formulations of the fish IBI was used (Table 3-12). The three strata used are: Coastal (COASTAL), Eastern Piedmont (EPIEDMNT), and Highlands (HIGHLAND).

3.2.5.5 Fish Index of Biotic Integrity (FIBI_98)

The fish IBI is a quantitative rating of the health of the fish assemblage found at each site (see Section 2.5.1 and Table 3-12). Scores range from 1 (very poor) to 5 (good). No fish IBI was calculated for sites with a catchment area less than 300 acres. The fish IBI may underrate coldwater and blackwater streams due to their naturally low species richness. Therefore, fish IBIs that were rated less than 3.0 at brook trout and blackwater sites were not reported (23 sites in total; for further detail, see Roth et. al 1998b).

3.2.5.6 Benthic Index of Biotic Integrity (BIBI_98)

The benthic IBI is a quantitative rating of the health of the benthic macroinvertebrate assemblage found at each site (see Section 2.5.1 and Table 3-12). Scores range from 1 (very poor) to 5 (good). The benthic IBI was not calculated at nine sites where sampling problems occurred that may have caused an underepresentation of the number of benthic taxa present.

3.2.5.7 Hilsenhoff Biotic Index (HILSNHOF)

The Hilsenhoff Index of Biotic Integrity is a quantitative rating of the health of the benthic macroinvertebrate assemblage found at each site, especially in response to organic pollution (see Section 2.5.2 and Table 3-12). Scores range from 0 (good) to 10 (very poor).

3.2.5.8 Ephemeroptera, Plecoptera, and Trichoptera Taxa Richness (EPT_TAXA)

Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness is a commonly used measure of benthic community health. EPT taxa are generally intolerant of poor water quality. Therefore, low numbers of EPT taxa may indicate poor stream health (see Section 2.5.2 and Table 3-12).

3.3 FISH

The data set FISH3YR contains the locational, water chemistry, physical habitat, land use, and indicator information included in Section 3-2. It also contains data relating to the fish species found at each site sampled including both the total gamefish and nongame fish biomass, the total number of fish species, the percent of fish with anomalies, and the abundance of each species at each site. This data set includes all sites that were sampled in the spring, whether they were sampled in the summer or not.

Table 3-13 lists the additional variables related to the fish found at each site.

Table 3-13. Additional contents of the data set FISH3YR containing 1995-1997 MBSS freshwater fish data

Variable	Type	Label/Common Name	Scientific Name
NSPECFISH	Num	Total Number of Fish Species	
NG_WT	Num	Total Nongame Fish Weight (g)	
TGAM_WT	Num	Total Gamefish Weight (g)	
PER_ANOM	Num	Percent of Fish with Anomalies	
AMBRLAMP	Num	AMERICAN BROOK LAMPREY	*Lampetra appendix*
AMEREEL	Num	AMERICAN EEL	*Anguilla rostrata*
BANKILLI	Num	BANDED KILLIFISH	*Fundulus diaphanus*
BANSUNFI	Num	BANDED SUNFISH	*Enneacanthus obesus*
BKNODACE	Num	BLACKNOSE DACE	*Rhinichthys atratulus*
BLKCRAPI	Num	BLACK CRAPPIE	*Pomoxis nigromaculatus*
BLSPSUNF	Num	BLUESPOTTED SUNFISH	*Enneacanthus gloriosus*
BLUEGILL	Num	BLUEGILL	*Lepomis macrochirus*
BLUNMINN	Num	BLUNTNOSE MINNOW	*Pimephales notatus*
BRKTROUT	Num	BROOK TROUT	*Salvelinus fontinalis*
BRNTROUT	Num	BROWN TROUT	*Salmo trutta*
BRWNBULL	Num	BROWN BULLHEAD	*Ameiurus nebulosus*
BULHEDSP	Num	BULLHEAD SP.	
CENSTROL	Num	CENTRAL STONEROLLER	*Campostoma anomalum*
CHCATFIS	Num	CHANNEL CATFISH	*Ictalurus punctatus*
CHKSCULP	Num	CHECKERED SCULPIN	*Cottus* sp. n.
CHNPIKRL	Num	CHAIN PICKEREL	*Esox niger*
CMLYSHIN	Num	COMELY SHINER	*Notropis amoenas*
COMMCARP	Num	COMMON CARP	*Cyprinus carpio*
COMSHINR	Num	COMMON SHINER	*Luxillus cornutus*
CREKCHUB	Num	CREEK CHUB	*Semotilus atromaculatus*

Table 3-13. Cont'd			
Variable	**Type**	**Label/Common Name**	**Scientific Name**
CRKCHBSK	Num	CREEK CHUBSUCKER	*Erimyzon oblongus*
CUTLMINW	Num	CUTLIPS MINNOW	*Exoglossum maxillingua*
CUTTROUT	Num	CUTTHROAT TROUT	*Oncorhynchus clarki*
CYPRINEL	Num	CYPRINELLA SP.	
CYPRINID	Num	CYPRINID SP.	
CYPRHYBR	Num	CYPRINID HYBRID	
DARTER	Num	DARTER SP.	
EMUDMINW	Num	EASTERN MUDMINNOW	*Umbra pygmaea*
ESILVMIN	Num	EASTERN SILVERY MINNOW	*Hybognathus regius*
FALLFISH	Num	FALLFISH	*Semotilus corporalis*
FANTDART	Num	FANTAIL DARTER	*Etheostoma flabellare*
FATHMINW	Num	FATHEAD MINNOW	*Pimephales promelas*
FLIER	Num	FLIER	*Centrarchus macropterus*
GIZZSHAD	Num	GIZZARD SHAD	*Dorosoma cepedianum*
GLASDART	Num	GLASSY DARTER	*Etheostoma vitreum*
GLDNREDH	Num	GOLDEN REDHORSE	*Moxostoma erythrurum*
GLDNSHNR	Num	GOLDEN SHINER	*Notemigonus crysoleucas*
GOLDFISH	Num	GOLDFISH	*Carassius auratus*
GRNDARTR	Num	GREENSIDE DARTER	*Etheostoma blennioides*
GRSUNFSH	Num	GREEN SUNFISH	*Lepomis cyanellus*
IRNCSHIN	Num	IRONCOLOR SHINER	*Notropis chalybaeus*
JOHNDART	Num	JOHNNY DARTER	*Etheostoma nigrum*
LAMPREY	Num	LAMPREY SP.	
LEPOMHYB	Num	LEPOMIS HYBRID	
LGMTHBAS	Num	LARGEMOUTH BASS	*Micropterus salmoides*
LNGEARSU	Num	LONGEAR SUNFISH	*Lepomis megalotis*
LNGNSGAR	Num	LONGNOSE GAR	*Lepisosteus osseus*
LOGPERCH	Num	LOGPERCH	*Percina caprodes*
LONGDACE	Num	LONGNOSE DACE	*Rhinichthys cataractae*
LSTBKLMP	Num	LEAST BROOK LAMPREY	*Lampetra aepyptera*
MARGMDTM	Num	MARGINED MADTOM	*Noturus insignis*
MOSQFISH	Num	MOSQUITOFISH	*Gambusia holbrooki*
MTLSCULP	Num	MOTTLED SCULPIN	*Cottus bairdi*

Table 3-13. Cont'd			
Variable	**Type**	**Label/Common Name**	**Scientific Name**
MUDSUNFI	Num	MUD SUNFISH	*Acantharchus pomotis*
MUMICHOG	Num	MUMMICHOG	*Fundulus heteroclitus*
NHOGSUKR	Num	NORTHERN HOGSUCKER	*Hypentelium nigricans*
PERLDACE	Num	PEARL DACE	*Margariscus margarita*
PIRPERCH	Num	PIRATE PERCH	*Aphredoderus sayanus*
POTSCULP	Num	POTOMAC SCULPIN	*Cottus girardi*
PUMPSEED	Num	PUMPKINSEED	*Lepomis gibbosus*
REDBRSUN	Num	REDBREAST SUNFISH	*Lepomis auritus*
REDPIKRL	Num	REDFIN PICKEREL	*Esox americanus*
RIVRCHUB	Num	RIVER CHUB	*Nocomis micropogon*
RNBOWDRT	Num	RAINBOW DARTER	*Etheostoma caeruleum*
RNBTROUT	Num	RAINBOW TROUT	*Oncorhynchus mykiss*
ROCKBASS	Num	ROCK BASS	*Ambloplites rupestris*
ROSYDACE	Num	ROSYSIDE DACE	*Clinostomus elongatus*
ROSYSHIN	Num	ROSYFACE SHINER	*Notropis rubellus*
SATFINSH	Num	SATINFIN SHINER	*Cyprinella analostana*
SCULPIN	Num	SCULPIN SP.	
SEALAMPR	Num	SEA LAMPREY	*Petromyzon marinus*
SHLDDART	Num	SHIELD DARTER	*Percina peltata*
SHRTREDH	Num	SHORTHEAD REDHORSE	*Moxostoma macrolepidotum*
SJAWMINW	Num	SILVERJAW MINNOW	*Notropis buccatus*
SMMTHBAS	Num	SMALLMOUTH BASS	*Micropterus dolomieu*
SPFNSHIN	Num	SPOTFIN SHINER	*Cyprinella spilopterus*
SPTLSHIN	Num	SPOTTAIL SHINER	*Notropis hudsonius*
STRPBASS	Num	STRIPED BASS	*Morone saxatilis*
STRPDART	Num	STRIPEBACK DARTER	*Percina notogramma*
STRPSHIN	Num	STRIPED SHINER	*Luxillus chrysocephalus*
SWMPDART	Num	SWAMP DARTER	*Etheostoma fusiforme*
SWSHINER	Num	SWALLOWTAIL SHINER	*Notropis procne*
TADPMADT	Num	TADPOLE MADTOM	*Noturus gyrinus*
TESSDART	Num	TESSELLATED DARTER	*Etheostoma olmstedi*
WARMOUTH	Num	WARMOUTH	*Lepomis gulosus*
WHITCATF	Num	WHITE CATFISH	*Ameiurus catus*
WHTPERCH	Num	WHITE PERCH	*Morone americana*

Table 3-13. Cont'd			
Variable	**Type**	**Label/Common Name**	**Scientific Name**
WHTSUCKR	Num	WHITE SUCKER	*Catostomus commersoni*
YLLWBULH	Num	YELLOW BULLHEAD	*Ameiurus natalis*
YLLWPRCH	Num	YELLOW PERCH	*Perca flavescens*

3.3.1 Number of Species of Fish (NSPECFISH)

The total number of fish species caught at each site (Table 3-13).

3.3.2 Aggregate Weights (NG_WT, TGAM_WT)

The aggregate (total) wet weights of nongame fish (NG_WT) and gamefish (TGAM_WT) species (Table 3-13). Values are given in grams.

3.3.3 Percent of Fish with Anomalies (PER_ANOM)

The percent of fish caught (both nongame and gamefish species) for which a visible, external anomaly was recorded (Table 3-13). This rough percentage was calculated as the number of anomalies observed divided by the number of fish examined per site. Because an individual fish could have more than one anomaly, this value may exceed 100%. A list of anomaly types examined for in the 1995-1997 MBSS is provided in Table 3-14. Only the first 100 individuals at each electrofishing pass were examined.

3.3.4 Fish Species Abundance

The presence and abundance of fish species collected along the 75-meter sample segment. Both gamefish and nongame fish are included.

The names of the fish species are represented by a series of variables, each up to eight characters long (e.g., AMEREEL for American eel; see Table 3-13). The value of each variable signifies the number of individuals of that species collected. For example, a record for one hypothetical site would include the following:

SITE	AMEREEL	BANKILLI	BKNODACE...
XX-X-123-123-XX	3	0	37 ...

The value of "3" for AMEREEL means three American eels were caught. In addition, thirty-seven blacknose dace were captured, while no banded killifish were caught.

Table 3-14. Pathological anomalies examined for in fish in the 1995-1997 MBSS	
Ocular Anomalies	
	Eye Cloudiness
	Eye Hemorrhage
	Exopthalmia (pop eye)
	Depression into the Orbits
	Eye Missing
	Cataract
Skin Anomalies	
	Discoloration
	Hemorrhaging
	Fin Cloudiness
	Raised Scales
	Growths/Cysts
	Ulcerations/Lesions
	Fin Erosion
	Swelling of the Anus
	Scale Deformation
	Fin Deformed or Missing
Skeletal Deformities	
	Deformities of the Vertebral Column
	Deformities of the Mandible
	Body Shape

3.4 AMPHIBIANS AND REPTILES

The data set HERP3YR contains the locational, water chemistry, physical habitat, land use, and indicator information included in Section 3-2. It also includes presence/absence data on amphibians and reptiles collected within each 75-meter sample segment and its adjacent riparian area during the summer index period (Table 3-15). Amphibians and reptiles were collected during electrofishing passes and by examination of representative habitats within 5 m of the stream segment.

3.4.1 Number of Amphibian and Reptile Species Present (NSPECHERP)

The total number of amphibian and reptile species caught at each site (Table 3-15).

Table 3-15. Additional contents of the data set HERP3YR containing 1995-1997 MBSS reptile and amphibian data

Variable	Type	Label/Common Name	Scientific Name
NSPECHRP	Num	Number of Amphibian and Reptile Species	
AMTOAD	Num	AMERICAN TOAD	*Bufo americanus*
BLRATSNK	Num	BLACK RAT SNAKE	*Elaphe o. obsoleta*
BULLFROG	Num	BULLFROG	*Rana catesbeiana*
EBOXTURT	Num	EASTERN BOX TURTLE	*Terrapene c. carolina*
EGARSNAK	Num	EASTERN GARTER SNAKE	*Thamnophis s. sirtalis*
EMUDSALA	Num	EASTERN MUD SALAMANDER	*Pseudotriton m. montanus*
EMUDTURT	Num	EASTERN MUD TURTLE	*Kinosternon s. subrubrum*
EPAITURT	Num	EASTERN PAINTED TURTLE	*Chrysemys p. picta*
ESMESNAK	Num	EASTERN SMOOTH EARTH SNAKE	*Virginia v. valeriae*
EWRMSNAK	Num	EASTERN WORM SNAKE	*Carphophis a. amoenus*
FIVLSKNK	Num	FIVE-LINED SKINK	*Eumeces fasciatus*
FROG	Num	FROG (UNKNOWN)	
FWLRTOAD	Num	FOWLER'S TOAD	*Bufo woodhousii fowleri*
GRENFROG	Num	GREEN FROG	*Rana clamitans melanota*
GRTRFROG	Num	GRAY TREEFROG	*Hyla versicolor,* *Hyla chrysoscelis*
JEFFRSAL	Num	JEFFERSON SALAMANDER	*Ambystoma jeffersonianum*
LNGTLSAL	Num	LONGTAIL SALAMANDER	*Eurycea l. longicauda*
MARBSALA	Num	MARBLED SALAMANDER	*Ambystoma opacum*
MNDSKSAL	Num	MOUNTAIN DUSKY SALAMANDER	*Desmognathus ochrophaeus*
MUSKTURT	Num	COMMON MUSK TURTLE	*Sternotherus odoratus*
N2LINSAL	Num	NORTHERN TWO-LINED SALAMANDER	*Eurycea bislineata*
NBLKRACR	Num	NORTHERN BLACK RACER	*Coluber c. constrictor*
NCOPPRHD	Num	NORTHERN COPPERHEAD	*Agkistrodon contortix mokasen*
NCRKFROG	Num	NORTHERN CRICKET FROG	*Acris c. crepitans*
NDSKYSAL	Num	NORTHERN DUSKY SALAMANDER	*Desmognathus f. fuscus*

Table 3-15. Cont'd

Variable	Type	Label/Common Name	Scientific Name
NFENLIZD	Num	NORTHERN FENCE LIZARD	*Sceloporus undulatus hyacinthinus*
NLEOPFRG	Num	NORTHERN LEOPARD FROG	*Rana pipiens*
NRNGSNAK	Num	NORTHERN RINGNECK SNAKE	*Diadophis punctatus edwardsii*
NSLIMSAL	Num	NORTHERN SLIMY SALAMANDER	*Plethodon glutinosus*
NSPRPEEP	Num	NORTHERN SPRING PEEPER	*Pseudacris c. crucifer*
NSPRSALA	Num	NORTHERN SPRING SALAMANDER	*Gyrinophilus porphyriticus*
NWATSNAK	Num	NORTHERN WATER SNAKE	*Nerodia s. sipedon*
PICKFROG	Num	PICKEREL FROG	*Rana palustris*
PLETHSAL	Num	PLETHODONTID SALAMANDER (UNKNOWN)	
QUENSNAK	Num	QUEEN SNAKE	*Regina septemvittata*
RANID	Num	RANID FROG (UNKNOWN)	
REDBSALA	Num	REDBACK SALAMANDER	*Plethodon cinereus*
REDBTURT	Num	REDBELLY TURTLE	*Pseudemys rubriventris*
REDSALAM	Num	RED SALAMANDER	*Pseudotriton ruber*
REDSPNWT	Num	RED SPOTTED NEWT	*Notopthalmus v. viridescens*
RGRNSNAK	Num	ROUGH GREEN SNAKE	*Opheodrys aestivus*
SALAMAND	Num	SALAMANDER (UNKNOWN)	
SELSALAM	Num	SEAL SALAMANDER	*Desmognathus monticola*
SLEOFROG	Num	SOUTHERN LEOPARD FROG	*Rana utricularia*
SMGRSNAK	Num	SMOOTH GREEN SNAKE	*Opheodrys vernalis*
SNAPTURT	Num	COMMON SNAPPING TURTLE	*Chelydra serpentina*
SPOTURTL	Num	SPOTTED TURTLE	*Clemmys guttata*
TOAD	Num	TOAD (UNKNOWN)	
WOODFROG	Num	WOOD FROG	*Rana sylvatica*
WOODTURT	Num	WOOD TURTLE	*Clemmys insculpta*

3.4.2 Amphibian and Reptile Taxa Collection

The names of amphibian and reptile taxa observed are represented by a series of variables, each up to eight characters long (e.g., AMTOAD for American toad; see Table 3-15). The value of each variable indicates the collection (1) of the taxa.

For example, in the data set HERP3YR, a record for one hypothetical site would include the following:

SITE	AMTOAD	BLRATSNK	BULLFROG. . .
XX-X-123-123-XX	0	0	1. . .

The value of "1" for BULLFROG means bullfrogs were collected. American toads and black rat snakes were not collected.

3.5 PLANTS

The data set PLNT3YR contains the locational, water chemistry, physical habitat, land use, and indicator information contained in Section 3-2. It also contains the number of species of plants (including both submerged and emergent aquatic vegetation) present and presence/absence data on species found within each 75-meter sample segment during the summer index period (Table 3-16). The presence of plants was observed at the time of electrofishing, by examination of the stream segment. Plants were identified to species when possible. Otherwise, a higher-level taxonomic identifier is given.

Table 3-16. Additional contents of the data set PLNT3YR containing 1995-1997 MBSS aquatic vegetation data

Variable	Type	Label/Common Name	Scientific Name
NSPECPLT	Num	Number of Plant Species	
ALISUBCO	Num	COMMON WATER PLANTAIN	*Alisma subcordatum*
CALITRHE	Num	LARGER WATER-STARWORT	*Callitriche heterophylla*
CALITRSP	Num	WATER-STARWORT	*Callitriche* sp.
CERATODE	Num	COONTAIL	*Ceratophyllum demersum*
ELODCANA	Num	ELODEA	*Elodea canadensis*
HYDROCOT	Num	WATER PENNYWORT	*Hydrocotyle* sp.
HYDRVERT	Num	HYDRILLA	*Hydrilla verticillata*

Table 3-16. Cont'd			
Variable	**Type**	**Label/Common Name**	**Scientific Name**
LEMNASP	Num	DUCKWEED	*Lemna* sp.
LUDWIGIA	Num	FALSE LOOSESTRIFE	*Ludwigia* sp.
LUDWPALU	Num	WATER PURSLANE	*Ludwigia palustris*
MYRISPIC	Num	EURASIAN WATERMILFOIL	*Myriophyllum spicatum*
NAJASSP	Num	NAIAD	*Najas* sp.
NASTOFFI	Num	WATERCRESS	*Nasturtium officinale*
NUPHRADV	Num	SPATTERDOCK	*Nuphar advena*
PLTVIRGA	Num	ARROW ARUM	*Peltandra virginica*
PODOCERA	Num	RIVERWEED	*Podotemum ceratophyllum*
PONTCORD	Num	PICKERELWEED	*Pontederia cordata*
POTMOCRI	Num	CURLY PONDWEED	*Potamogeton crispus*
POTMOEPI	Num	FLOATING PONDWEED	*Potamogeton epihydrus*
POTMOGTN	Num	PONDWEED	*Potamogeton* sp.
POTMOPUS	Num	SMALL PONDWEED	*Potamogeton pusillus*
SAGITTAR	Num	ARROW HEAD	*Sagittaria* sp.
SAURCERN	Num	LIZARDS TAIL	*Saururus cernuus*
SAV	Num	SAV (UNKNOWN)	
SPARGNSP	Num	BURREED	*Sparganium* sp.
TYPHASP	Num	CATTAIL	*Typha* sp.
VALLAMER	Num	WATER CELERY	*Vallisneria americana*

3.5.1 Number of Plant Species Present (NSPECPLT)

The total number of aquatic plant species present at each site (Table 3-16).

3.5.2 Plant Taxa Collection

The names of macrophyte taxa observed are represented by a series of variables, each up to eight characters long (e.g., ALISUBCO for *Alisma subcordatum*, the common water plantain; see Table 3-16). A value of "1" indicates that the taxon was collected, while a value of "0" indicates that it was not.

3.6 MUSSELS

The data set MUSS3YR (Table 3-17) contains presence/absence data on freshwater mussels found within each 75-meter sample segment during the summer index period. The presence of mussels was observed at the time of electrofishing, by examining habitat within the stream segment. Mussels were identified to species.

Table 3-17. Additional contents of the data set MUSS3YR containing 1995-1997 MBSS freshwater mussel data

Variable	Type	Label/Common Name	Scientific Name
NSPECMUS	Num	Number of Mussel Species	
ALEFLOAT	Num	ALEWIFE FLOATER	*Anodonta implicata*
ASIACLAM	Num	ASIATIC CLAM	*Corbicula fluminea*
ATLASPIK	Num	ATLANTIC SPIKE	*Elliptio producta*
EELLIPTI	Num	EASTERN ELLIPTIO	*Elliptio complanata*
EFLOATER	Num	EASTERN FLOATER	*Anondonta cataracta*
MUSSEL	Num	MUSSEL (UNKNOWN)	
NLANCE	Num	NORTHERN LANCE	*Elliptio fisheriana*
SQUAWFT	Num	SQUAWFOOT	*Strophitus undulatus*
YLANCE	Num	YELLOW LANCE	*Elliptio lanceolata*

3.6.1 Number of Mussel Species Present (NSPECMUS)

The total number of bivalve species present at each site (Table 3-17).

3.6.2 Mussel Taxa Collection

The names of mussel taxa observed are represented by a series of variables, each up to eight characters long (e.g., ASIACLAM for Asian clam; see Table 3-17). A value of "1" indicates that a taxon was collected, while a value of "0" indicates that it was not.

3.7 BENTHIC MACROINVERTEBRATES

The data set BENT3YR (Table 3-18) contains data on benthic macroinvertebrates collected at each 1995-1997 MBSS site during the spring index period. Benthic fauna were collected from a variety of instream habitats. The sample was transferred to a gridded pan and organisms were picked from randomly selected grid cells until the cell that contained the 100th individual was completed. These data provide an estimate of proportions of different taxa sampled, but do not provide information on abundance. Note that actual abundance could greatly exceed the number of individuals in the sample. Benthic macroinvertebrates were identified to genus level where possible. Otherwise, a higher taxonomic designation was used.

Each record in the data set BENT3YR refers to a different taxa, with the site information repeated for each taxa found at the site. There may be multiple lines per site.

Table 3-18. Contents of the data set BENT3YR 1995-1997 MBSS benthic macroinvertebrate data

Variable	Type	Label
SITE	Char	Site
ORDER	Num	Strahler Stream Order
BASIN	Char	Basin
COUNTY	Char	County
SHEDCODE	Num	Maryland 8-digit Watershed Code
SHEDNAME	Num	Maryland 8-digit Watershed Name
DATE_SPR	Num	Date Actually Sampled - Spring
TAXON	Char	Benthic Taxa Name
N_TAXA	Num	Number of Individuals Counted
N_GRIDS	Num	Number of Grids

3.7.1 Site Identifiers (SITE, ORDER, COUNTY, BASIN, SHEDNAME, SHEDCODE)

The variable SITE identifies the sample segment at which the data were collected. ORDER is the Strahler stream order of that site. The remaining site identifiers help to locate each site in a specific county, basin, and watershed and are useful for sorting the data (see Table 3-18).

3.7.2 Actual Sample Date - Spring (DATE_SPR)

The date sampling occurred at a site during the spring index period (Table 3-18).

3.7.3 Benthic Taxa Name (TAXON)

The scientific name of each benthic taxa identified at each site (Table 3-18). A list of all benthic taxa collected in the 1995-1997 MBSS is given in Appendix B.

3.7.4 Number of Individuals (N_TAXA)

The number of individuals of each benthic taxa identified of the roughly 100 individuals counted at each site (Table 3-18).

3.7.5 Number of Grids (N_GRIDS)

The number of grids on the gridded pan that were needed in order to identify 100 benthic individuals at each site (Table 3-18). The number of grids was recorded for most, but not all sites.

4 GUIDELINES FOR DATA ANALYSIS

4.1 ESTIMATING MEANS, TOTALS, AND PROPORTIONS

Estimation of summary statistics for each stream order in a basin is straightforward since sites are randomly selected within each stream order. Estimation across stream order must take into account the stratified random sampling. Estimates are first calculated by stream order, and then combined by an appropriate weighting. The weight for each order is the fraction of stream miles in that order. Cochran (1977) provides estimators for means, proportions and totals, and their variances for random and stratified random sampling. Additional information on the appropriate statistical methods for analyzing MBSS 1995-1997 data can be found in Roth et al. (1999).

5 REFERENCES

Barbour, M. T., and J. B. Stribling. 1991. Use of habitat assessment in evaluating the biological integrity of stream communities. *In*: Biological Criteria: Research and Regulation, 25-38. U.S. Environmental Protection Agency, Washington, D.C. EPA-440/5-91-005.

Bode, R.W. 1988. Methods for Rapid Biological Assessment of Streams. New York State Department of Environmental Conservation report, Albany, NY.

Bode, R.W. and M.A. Novak. 1995. Development and application of biological impairment criteria for rivers and streams in New York State. In: W.S. Davis and T.P. Simon., eds. Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL. Pp. 97-107.

Buchanan, T.J. and W.P. Somers. Undated. Discharge measurements at gaging stations. *In:* Techniques of water-resources investigations.

Chaillou, J. 1995. Technical Memorandum, The Maryland Biological Stream Survey: Summary of Landowner Contact Procedures. Prepared for Maryland Department of Natural Resources, Chesapeake Bay Research and Monitoring Division, by Versar, Inc., Columbia, MD.

Cochran, W. G. 1977. Sampling Techniques. 3rd ed. New York: John Wiley and Sons.

EPA (U.S. Environmental Protection Agency). 1987. Handbook of methods for acid deposition studies: Laboratory analysis for surface water chemistry. EPA-600/4-87/026.

Hall L.W., Jr. and R. Morgan. 1999. Personal Communication with L. Hall, University of Maryland Wye Research and Education Center, Queenstown, MD and R. Morgan, University of Maryland Appalachian Laboratory, Frostburg, MD.

Hilsenhoff, W.L. 1987. An improved biotic index or organic stream pollution. Great Lakes Entomologist 20:31-39.

Hilsenhoff, W.L. 1977. Use of arthropods to evaluate water quality in streams. Wisconsin Department of Natural Resources, Technical Bulletin No. 100.

Janicki, A., D. Wade, D. Heimbuch, H. Wilson, P. Jacobson, P. Kazyak. 1993. Maryland Biological Stream Survey design report. Prepared for Maryland Department of Natural Resources, Chesapeake Bay Research and Monitoring Division, by Coastal Environmental Services, Linthicum, MD. CBRM-AD-93-1.

Jessen, R. J. 1978. Statistical Survey Techniques. John Wiley. New York.

Kazyak, P. F. 1997. Maryland Biological Stream Survey Sampling Manual. Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface waters. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Cincinnati, OH. EPA/600/4-90/030.

Lenat, D.R. 1993. A biotic index for the southeastern United States: Derivation and list of tolerance values, with criteria for assigning water quality ratings. Journal of the North American Benthological Society 12:279-290.

MRLC (Multi-Resolution Land Characteristics Consortium) 1996a. U.S. Federal Region III land cover data set: metadata. MRLC website, http://www.epa.gov/mrlc/R3Meta.html

MRLC. 1996b. U.S. Federal Region III land cover Version 2.0 metadata. MRLC website, http://www.epa.gov/mrlc/R3Meta.README.html

Ohio EPA (Ohio Environmental Protection Agency). 1987. Biological criteria for the protection of aquatic life. Volumes I-III. Ohio EPA, Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 440-4-89-001.

Rankin, E.T. 1989. The Qualitative Habitat Evaluation Index [QHEI]: Rationale, methods, and application. Ohio EPA, Columbus, OH.

Roth, N.E., M.T. Southerland, J.C. Chaillou, R.J. Klauda, P.F. Kazyak, S.A. Stranko, S.B. Weisberg, L.W. Hall, Jr., and R.P. Morgan II. 1998a. Maryland Biological Stream Survey: Development of a Fish Index of Biotic Integrity. Environmental Management and Assessment 51:89-106.

Roth, N.E., M.T. Southerland, J.C. Chaillou, H.T. Wilson, D.G. Heimbuch, and J.C. Seibel. 1998b. Maryland Biological Stream Survey: Ecological Status of Non-tidal Streams Sampled in 1996. Prepared by Versar, Inc., Columbia, MD, and Post, Buckley, Schuh, and Jernigan, Inc., Bowie, MD, for Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. CBWP- MANTA-EA-98-1.

Roth, N.E., M.T. Southerland, J.C. Chaillou, J.H. Volstad, S.B. Weisberg, H.T. Wilson, D.G. Heimbuch, and J.C. Seibel. 1997. Maryland Biological Stream Survey: Ecological Status of Non-Tidal Streams in Six Basins Sampled in 1995. Prepared by Versar, Inc., Columbia, MD, and Coastal Environmental Services, Linthicum, MD for Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. CBWP-MANTA-EA-97-2.

Roth, N.E., M.T. Southerland, G. Mercurio, J.C. Chaillou, D.G. Heimbuch, and J.C. Seibel, 1999 State of the Streams: 1995-1997 Maryland Biological Stream Survey Results. Prepared by Versar Inc., Columbia MD, and Post, Buckley, Schuh, and Jernigan, Inc., Bowie MD for Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division.

Strahler, A. N. 1957. Quantitative analysis of watershed geomorphology. American Geophysical Union, Transactions 38(6): 913-920.

Stribling J.B., B.K. Jessup, J.S. White, D. Boward, and M. Hurd. 1998. Development of a Benthic Index of Biotic Integrity for Maryland Streams. Prepared by Tetra Tech, Inc., Owings Mills, MD and Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Program. CBWP-MANTA-EA-98-3.

Vølstad, J. H., M. T. Southerland, S. B. Weisberg, H. T. Wilson, D. G. Heimbuch, and J. C. Seibel. 1996. Maryland Biological Stream Survey: The 1994 Demonstration Project. Prepared for Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division, by Versar, Inc., Columbia, MD.

Vølstad, J. H., M. Southerland, J. Chaillou, H. Wilson, D. Heimbuch, P. Jacobson and S. Weisberg. 1995. The Maryland Biological Stream Survey: The 1993 Pilot Study. Prepared for Maryland Department of Natural Resources, Chesapeake Bay Research and Monitoring Division, by Versar, Inc., Columbia, MD.

APPENDIX A

MBSS 1995-1997 Data Sheets

MBSS SPRING INDEX PERIOD DATA SHEET

SAMPLE SEGMENT County ___ ___ - Region ___ - Reach ID ___ ___ ___ - Segment ___ ___ ___

Reviewed By: ____________

2nd Reviewer: ____________

BASIN ___ ___ (see back for codes)

CREW ____________

DATE Y Y ___ ___ M M ___ ___ D D ___ ___

STREAM ____________

TIME (Military) ___ ___ ___ ___

COMMENTS ____________

SAMPLEABILITY

Can segment be sampled? (Y/N) ___

If no, for what reasons? ___

- 1 = Dry Streambed
- 2 = Too Deep
- 3 = Marsh, no defined channel
- 4 = Excessive Riparian Vegetation
- 5 = Impoundment
- 6 = Tidally Influenced
- 7 = Permission Denied
- 8 = Unsafe (describe in comments)
- 9 = Other

PHOTODOCUMENTATION
(Optional If Sampleable)

Roll #/Frame #	Title
___ ___ - ___ ___	
___ ___ - ___ ___	
___ ___ - ___ ___	

ROAD CULVERT

Present in Segment? (Y/N) ___

Sampleable? (Y/N) ___

Width of Culvert (m) ___ ___

SITE ACCESS ROUTE: ____________

Bottle Label Verified by: ____________

Syringe Label Verified by: ____________

QC LABEL

County ___ ___ - Region ___ - Reach ID ___ ___ ___ - Segment ___ ___ ___

Bottle label verified by: ____________

Syringe label verified by: ____________

Benthos label verified by: ____________

Duplicate(D) or Blank(B): ___

BENTHIC HABITAT SAMPLED
(Square feet; Total = 20 square feet)

___ ___ ___ Riffle

___ ___ ___ Rootwad/Woody Debris/Leak Pack

___ ___ ___ Macrophytes

___ ___ ___ Undercut Banks

___ ___ ___ Other (specify)

STREAM WIDTH (m) 0 m ___ ___ ___ . ___ 75 m ___ ___ ___ . ___

MBSS Drainage Basin Codes

YG = Youghiogheny River
NO = North Branch Potomac River
UP = Upper Potomac River
MP = Middle Potomac River
CO = Conawago Creek
PW = Potomac Washington Metro

LP = Lower Potomac River
PX = Patuxent River
WC = West Chesapeake
PP = Patapsco River
BU = Bush River
GU = Gunpowder River

SQ = Lower Susquehanna River
EL = Elk River
CR = Chester River
CK = Choptank River
NW = Nanticoke-Wicomico Rivers
PC = Pocomoke River
OC = Ocean Coastal

MBSS NON-GAME FISH DATA SHEET

Page [ ] of [ ]

SAMPLE SEGMENT County [ ][ ] – Region [ ] – Reach ID [ ][ ][ ] – Segment [ ][ ][ ]

Reviewed By: ____________

DATE Y Y [ ][ ] M M [ ][ ] D D [ ][ ]

2nd Reviewer: ____________

Fish Movement During Net Installation? (Y/N) [ ]

Can Bottom be Seen in all Areas of Segment? (Y/N) [ ]

Same Water Clarity on 2nd Pass? (Y/N) [ ]

Voltage [ ][ ][ ][ ] Hz [ ][ ][ ]

Length of Segment Actually Sampled (m) [ ][ ]

	Unit 1	Unit 2	Unit 3
Anodes/Unit			
Time (sec) Begin 1st pass			
Time (sec) Begin 2nd pass			
Time (sec) End 2nd pass			

Fish Captured? (Y/N) [ ]

NON-GAME SPECIES (Append A for Name Spelling)	Re-tained? (Y/N)	1st Pass Catch (Total)	2nd Pass Catch (Total)	# Exam for Anom (100 max)	Type & # of Anomalies (see back of Habitat Data Sheet) No.	Type	No.	Type

Aggreg Non-Game Fish Biomass [ ][ ][ ][ ][ ] | [ ][ ][ ][ ][ ] (g)

MBSS GAME FISH DATA SHEET

Page ___ of ___

SAMPLE SEGMENT County ___ – Region ___ – Reach ID ___ – Segment ___

Reviewed By: ___

2nd Reviewer: ___

DATE YY ___ MM ___ DD ___

1ST Pass Gamefish			___ Pass Gamefish		
SPECIES	LENGTH (TL; mm)	ANOM TYPE	SPECIES	LENGTH (TL; mm)	ANOM TYPE
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					

Aggregate Gamefish Biomass (g) ___

2ND PASS Aggreg Game Biomass ___

MBSS SUMMER INDEX PERIOD DATA SHEET

Page ☐ of ☐

SAMPLE SEGMENT County ☐☐ - Region ☐ - Reach ID ☐☐☐ - Segment ☐☐☐

Reviewed By: ____________

BASIN ☐☐ (see back for codes)   **CREW** ____________

2nd Reviewer: ____________

DATE Y Y ☐☐ M M ☐☐ D D ☐☐   **STREAM** ____________

TIME (Military) ☐☐☐☐

COMMENTS ____________

Can segment be sampled? (Y/N) ☐

If no, for what reasons? ☐

1 = Dry Streambed
2 = Too Deep
3 = Marsh, no defined channel
4 = Excessive Riparian Vegetation
5 = Impoundment
6 = Tidally Influenced
7 = Permission Denied
8 = Unsafe (describe in comments)
9 = Other

HERPETOFAUNA

Taxa Observed	Retained? (Y/N)

AQUATIC PLANTS

Taxa Observed	Retained? (Y/N)

MUSSELS

Taxa Observed	Retained? (Y/N)

WATER QUALITY

Temp (C)	DO (ppm)	pH	Cond (umho/cm)	Turbidity (NTU)
☐☐.☐	☐☐.☐	☐.☐☐	☐.☐☐☐	☐☐☐.☐

Meter Calibration Date ____________ by: ____________

MBSS Drainage Basin Codes

YG =Youghiogheny River
NO =North Branch Potomac River
UP Upper Potomac River
MP Middle Potomac River
CO Conawago Creek
PW Potomac Washington Metro

LP Lower Potomac River
PX Patuxent River
WC West Chesapeake
PP Patapsco River
BU Bush River
GU Gunpowder River

SO Lower Susquehanna River
EL Elk River
CR Chester River
CK Choptank River
NW Nanticoke-Wicomico Rivers
PC Pocomoke River
OC Ocean Coastal

MBSS GAME FISH DATA SHEET (continued)

Page ___ of ___

SAMPLE SEGMENT County ___ Region ___ – Reach ID ___ – Segment ___

Reviewed By: ___________

DATE Y Y ___ M M ___ D D ___

2nd Reviewer: ___________

___ Pass Gamefish				___ Pass Gamefish		
SPECIES	LENGTH (TL; mm)	ANOM TYPE		SPECIES	LENGTH (TL; mm)	ANOM TYPE
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						
26.						
27.						
28.						
29.						
30.						

1ST PASS NUMBER NOT MEASURED ___

2ND PASS NUMBER NOT MEASURED ___

MBSS STREAM HABITAT ASSESSMENT DATA SHEET

Page ☐ of ☐

SAMPLE SEGMENT County ☐☐ – Region ☐ – Reach ID ☐☐☐ – Segment ☐☐☐

Reviewed by: ____________

2nd Reviewer: ____________

BASIN ☐☐ (see back for codes)

DATE Year ☐☐ Month ☐☐ Day ☐☐

CREW: ____________

TIME ☐☐☐☐ (Military)

STREAM:

LANDUSE

- ☐ Old Field
- ☐ Deciduous Forest
- ☐ Coniferous Forest
- ☐ Wetland
- ☐ Surface Mine
- ☐ Landfill
- ☐ Residential
- ☐ Commercial/Industrial
- ☐ Cropland
- ☐ Pasture
- ☐ Orchard/Vineyard/Nursery

STREAM CHARACTER

- ☐ Meandering
- ☐ Braided
- ☐ Channelized
- ☐ Straight
- ☐ Riffle
- ☐ Run/Glide
- ☐ Deep Pool >=.5m
- ☐ Shallow Pool ,.5m
- ☐ Boulder>2m
- ☐ Boulder <2m
- ☐ Cobble
- ☐ Bedrock
- ☐ Gravel
- ☐ Sand
- ☐ Silt/Clay
- ☐ Concrete/Gabion
- ☐ Rootwad
- ☐ Undercut Bank
- ☐ Overhead Cover
- ☐ Human Refuse
- ☐ Emergent Vegetation
- ☐ Submergent Vegetation
- ☐ Floating Vegetation
- ☐ Storm Drain
- ☐ Effluent Discharge
- ☐ Beaver Pond

☐ No. of Woody Debris

☐ No. of Rootwads

HABITAT ASSESSMENT

1. Instream Habitat (0-20)............... ☐☐
2. Epifaunal Substrate (0-20)........... ☐☐
3. Velocity/Depth Diversity (0-20).... ☐☐
4. Pool/Glide/Eddy Quality (0-20).... ☐☐
5. Riffle/Run Quality (0-20)............ ☐☐
6. Channel Alteration (0-20)........... ☐☐
7. Bank Stability (0-20)................. ☐☐
8. Embeddedness (%)..................... ☐☐☐
9. Channel Flow Status (%)............ ☐☐☐
10. Shading (%)............................ ☐☐☐
11. Riparian Buffer Zone Width (m).... ☐☐

    Buffer Type (see back)............ ☐☐

    Adjacent Land Cover (see back) ☐☐
12. Remoteness (0-20).................. ☐☐
13. Aesthetic Rating (0-20)............ ☐☐

Maximum Depth (cm) ☐☐☐

	Wetted Width (m)	Thalweg Depth (cm)	Thalweg Velocity (m/s)
0m			
25m			
50m			
75m			

Overbank Flood Height (m) ☐☐

FLOW

Lat Loc(m)	Depth(cm)	Velocity (m/s)

Alternative Flow Measurements

Distance (1m)

Depth (cm) ☐

Width (cm) ☐☐

Time (sec) 1. ☐☐☐

2. ☐☐☐

3. ☐☐☐

Stream Gradient (%) ☐☐☐

Straight Line Segment Length (m) ☐☐

Stream Block Ht. (m) ☐☐

Stream Block Type ☐☐

Lat ☐☐☐☐☐☐ deg min sec

Lon ☐☐☐☐☐☐

COMMENTS ____________

Riparian Buffer Zone/
Adjacent Land Cover Types

FR = Forest
OF = Old Field
EM = Emergent Vegetation
LN = Mowed Lawn
TG = Tall Grass
LO = Logged Area

SL = Bare Soil
RR = Railroad
PV = Paved Road
PK = Parking Lot/Industrial/Commerical
GR = Gravel Road
DI = Dirt Road
PA = Pasture
OR = Orchard
CP = Cropland
HO = Housing

ANOMALLY TYPES (for Summer Index Period Data Set)

Body Surfaces and Fins

DI = Discoloration
HM = Hemorrhaging
CL = Fin Cloudiness
RS = Raised Scales
BL = Black Spot
EP = Visible External Parasites
GR - Growths/Cysts
UL = Ulcerations/Lesions
FI = Fin Erosion
DV = Deformities of the Vertebral Column
DM = Deformities of the Mandible
AN = Swelling of the Anus
SC = Scale Deformities
RE = Red Spot
HK = Hooking Injury
OT = Other (define in comments section)

BS = Body Shape
FD = Fin deformed or missing
CT = Cut
IK = Ich
AW = Anchor Worm
LE = Leeches

Eyes

EC = Eye Cloudiness
EH = Eye Hemorrhage
PO = Exopthalmia (pop eye)
OR = Depression into the Orbits
NO = Eye Missing
CA = Cataract

(Note: Height is measured in meters from stream surface to water surface above structure)

INSTREAM BLOCKAGE CODES

DM = Dam
PC = Pipe Culvert
F = Fishway
GW = Gaging Station Weir
G = Gabion
PX = Pipeline Crossing
AC = Arch Culvert
BC = Box Culvert
TG = Tide Gate

MBSS Drainage Basin Codes

YG = Youghiogheny River
NO = North Branch Potomac River
UP = Upper Potomac River
MP = Middle Potomac River
CO = Conawago Creek
PW = Potomac Washington Metro

LP = Lower Potomac River
PX = Patuxent River
WC = West Chesapeake
PP = Patapsco River
BU = Bush River
GU = Gunpowder River

SQ = Lower Susquehanna River
EL = Elk River
CR = Chester River
CK = Choptank River
NW = Nanticoke-Wicomico Rivers
PC = Pocomoke River
OC = Ocean Coastal

APPENDIX B

Benthic Macroinvertebrate Taxa Recorded in the 1995-1997 MBSS

Appendix B

Table B-1. List of benthic macroinvertebrate taxa recorded in the 1995-97 MBSS

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
Nematomorpha						Nematomorpha	1
Enopla	Hoplonemertea	Tetrastemmatidae					
					Prostoma	Prostoma	
Turbellaria							
	Tricladida	Planariidae					
					Cura	Cura	
					Dugesia	Dugesia	
Oligochaeta							
	Lumbriculida	Lumbriculidae				Lumbriculidae	
	Tubificida	Enchytraeidae				Enchytraeidae	2
		Naididae				Naididae	2
		Tubificidae					2
					Limnodrilus	Limnodrilus	
					Spirosperma	Spirosperma	
Hirudinea							
	Pharyngobdellida	Erpobdellidae					
					Mooreobdella	Mooreobdella	
	Rhynchobdellida	Glossiphoniidae					
					Helobdella	Helobdella	
		Piscicolidae			Piscicola	Piscicola	
Gastropoda	Basommatophora	Ancylidae					
					Ferrissia	Ferrissia	
		Lymnaeidae					
					Fossaria	Fossaria	
					Pseudosuccinea	Pseudosuccinea	
					Radix	Radix	
					Stagnicola	Stagnicola	
		Physidae					
					Physella	Physella	
		Planorbidae					
					Gyraulus	Gyraulus	
					Helisoma	Helisoma	
					Menetus	Menetus	
					Planorbella	Planorbella	
					Promenetus	Promenetus	
	Mesogastropoda	Bithyniidae			Bithynia	Bithynia	
		Hydrobiidae					
					Amnicola	Amnicola	
					Hydrobia	Hydrobia	
		Pleuroceridae			Goniobasis	Goniobasis	
					Leptoxis	Leptoxis	
		Valvatidae			Valvata	Valvata	
		Viviparidae			Campeloma	Campeloma	
					Viviparus	Viviparus	

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note

Pelecypoda	Unionoida	Unionidae		Unionidae	3
	Veneroida	Corbiculidae	Corbicula		
		Sphaeriidae			
			Pisidium	Pisidium	
			Sphaerium	Sphaerium	
Malacostraca	Amphipoda				
		Crangonyctidae			
			Crangonyx	Crangonyx	
		Gammaridae	Gammarus	Gammarus	
			Stygonectes	Stygonectes	
		Hyalellidae	Hyalella	Hyalella	
	Copepoda			Copepoda	
	Decapoda	Cambaridae			
			Cambarus	Cambarus	
			Orconectes	Orconectes	
		Palaemonidae	Palaemonetes	Palaemonetes	
	Isopoda				
		Asellidae	Caecidotea	Caecidotea	
	Ostracoda			Ostracoda	
			Lirceus	Lirceus	
Insecta	Collembola				
		Isotomidae	Isotomurus	Isotomurus	
	Ephemeroptera				
		Ameletidae			
			Ameletus	Ameletus	
		Baetidae			
			Acentrella	Acentrella	
			Acerpenna	Acerpenna	
			Baetis	Baetis	
			Barbaetis	Barbaetis	
			Callibaetis	Callibaetis	
			Centroptilum	Centroptilum	
			Diphetor	Diphetor	
			Procloeon	Procloeon	
		Baetiscidae	Baetisca	Baetisca	
		Caenidae	Caenis	Caenis	
		Ephemerellidae			
			Drunella	Drunella	
			Ephemerella	Ephemerella	
			Eurylophella	Eurylophella	
			Serratella	Serratella	
			Timpanoga	Timpanoga	
		Ephemeridae	Ephemera	Ephemera	
			Hexagenia	Hexagenia	

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
		Heptageniidae					
					Cinygmula	Cinygmula	
					Epeorus	Epeorus	
					Heptagenia	Heptagenia	
					Leucrocuta	Leucrocuta	
					Nixe	Nixe	
					Stenacron	Stenacron	
					Stenonema	Stenonema	
		Isonychiidae			Isonychia	Isonychia	
		Leptophlebiidae					
					Habrophlebia	Habrophlebia	
					Leptophlebia	Leptophlebia	
					Paraleptophlebia	Paraleptophlebia	
		Metretopodidae			Siphloplectron	Siphloplectron	
		Potamanthidae			Anthopotamus	Anthopotamus	
		Siphlonuridae					
					Siphlonurus	Siphlonurus	
	Odonata						
		Aeshnidae					
					Basiaeschna	Basiaeschna	
					Boyeria	Boyeria	
		Calopterygidae			Calopteryx	Calopteryx	
		Coenagrionidae					
					Argia	Argia	
					Enallagma	Enallagma	
					Ischnura	Ischnura	
					Nehalennia	Nehalennia	
		Cordulegastridae			Cordulegaster	Cordulegaster	
		Corduliidae					
					Macromia	Macromia	
					Somatochlora	Somatochlora	
		Gomphidae					
					Arigomphus	Arigomphus	
					Dromogomphus	Dromogomphus	
					Erpetogomphus	Erpetogomphus	
					Gomphus	Gomphus	
					Hagenius	Hagenius	
					Lanthus	Lanthus	
					Progomphus	Progomphus	
					Stylogomphus	Stylogomphus	
		Libellulidae					
					Leucorrhinia	Leucorrhinia	
					Libellula	Libellula	

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
	Plecoptera	Capniidae					
					Allocapnia	Allocapnia	
					Capnia	Capnia	
					Paracapnia	Paracapnia	
		Chloroperlidae					
					Alloperla	Alloperla	
					Haploperla	Haploperla	
					Perlinella	Perlinella	
					Sweltsa	Sweltsa	
		Leuctridae					
					Leuctra	Leuctra	
					Paraleuctra	Paraleuctra	
		Nemouridae					
					Amphinemura	Amphinemura	
					Nemoura	Nemoura	
					Ostrocerca	Ostrocerca	
					Prostoia	Prostoia	
					Shipsa	Shipsa	
					Soyedina	Soyedina	
		Peltoperlidae					
					Peltoperla	Peltoperla	
					Tallaperla	Tallaperla	
		Perlidae					
					Acroneuria	Acroneuria	
					Eccoptura	Eccoptura	
					Neoperla	Neoperla	
					Paragnetina	Paragnetina	
					Perlesta	Perlesta	4
					Phasganophora	Phasganophora	5
		Perlodidae					
					Clioperla	Clioperla	
					Cultus	Cultus	
					Diploperla	Diploperla	
					Isoperla	Isoperla	
					Malirekus	Malirekus	
		Pteronarcyidae			Pteronarcys	Pteronarcys	
		Taeniopterygidae					
					Oemopteryx	Oemopteryx	
					Strophopteryx	Strophopteryx	
					Taeniopteryx	Taeniopteryx	
	Hemiptera	Belostomatidae			Belostoma	Belostoma	6
		Corixidae					
					Palmacorixa	Palmacorixa	
					Trichocorixa	Trichocorixa	

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
		Gerridae			Gerris	Gerris	
					Trepobates	Trepobates	
		Notonectidae			Notonecta	Notonecta	
		Veliidae			Microvelia	Microvelia	
	Megaloptera	Corydalidae			Chauliodes	Chauliodes	
					Corydalus	Corydalus	
					Nigronia	Nigronia	
		Sialidae					
					Sialis	Sialis	
	Neuroptera	Sisyridae			Climacia	Climacia	7
	Trichoptera						
		Brachycentridae					
					Brachycentrus	Brachycentrus	
					Micrasema	Micrasema	
		Calamoceratidae			Heteroplectron	Heteroplectron	
		Dipseudopsidae			Phylocentropus	Phylocentropus	8
		Glossosomatidae					
					Agapetus	Agapetus	
					Glossosoma	Glossosoma	
		Hydropsychidae					
					Cheumatopsyche	Cheumatopsyche	
					Diplectrona	Diplectrona	
					Homoplectra	Homoplectra	
					Hydropsyche	Hydropsyche	
					Parapsyche	Parapsyche	
		Hydroptilidae					
					Hydroptila	Hydroptila	
					Leucotrichia	Leucotrichia	
					Ochrotrichia	Ochrotrichia	
					Oxyethira	Oxyethira	
		Lepidostomatidae			Lepidostoma	Lepidostoma	
		Leptoceridae					
					Ceraclea	Ceraclea	
					Mystacides	Mystacides	
					Nectopsyche	Nectopsyche	
					Oecetis	Oecetis	
					Triaenodes	Triaenodes	
		Limnephilidae					
					Goera	Goera	
					Hydatophylax	Hydatophylax	
					Ironoquia	Ironoquia	
					Limnephilus	Limnephilus	
					Platycentropus	Platycentropus	
					Pycnopsyche	Pycnopsyche	

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
		Odontoceridae			Psilotreta	Psilotreta	
		Philopotamidae					
					Chimarra	Chimarra	
					Dolophilodes	Dolophilodes	
					Wormaldia	Wormaldia	
		Phryganeidae			Ptilostomis	Ptilostomis	
		Polycentropodidae					
					Neureclipsis	Neureclipsis	
					Nyctiophylax	Nyctiophylax	
					Polycentropus	Polycentropus	
		Psychomyiidae			Lype	Lype	
					Psychomyia	Psychomyia	
		Rhyacophilidae			Rhyacophila	Rhyacophila	
		Uenoidae					
					Neophylax	Neophylax	9
	Lepidoptera						
		Pyralidae				Pyralidae	
		Tortricidae				Tortricidae	
	Coleoptera	Curculionidae				Curculionidae	
		Dryopidae			Helichus	Helichus	
		Dytiscidae					
					Agabus	Agabus	
					Cybister	Cybister	
					Deronectes	Deronectes	
					Derovatellus	Derovatellus	
					Hydroporus	Hydroporus	
		Elmidae					
					Ancyronyx	Ancyronyx	
					Dubiraphia	Dubiraphia	
					Macronychus	Macronychus	
					Optioservus	Optioservus	
					Oulimnius	Oulimnius	
					Promoresia	Promoresia	
					Stenelmis	Stenelmis	
		Gyrinidae			Dineutus	Dineutus	
					Gyrinus	Gyrinus	
		Haliplidae			Haliplus	Haliplus	
					Peltodytes	Peltodytes	
		Hydrophilidae			Berosus	Berosus	
					Enochrus	Enochrus	
					Hydrobius	Hydrobius	
					Hydrochus	Hydrochus	
					Hydrophilus	Hydrophilus	
					Sperchopsis	Sperchopsis	

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
					Tropisternus	Tropisternus	
		Psephenidae			Ectopria	Ectopria	
					Psephenus	Psephenus	
		Ptilodactylidae			Anchytarsus	Anchytarsus	
		Scirtidae					
					Cyphon		
	Diptera						
		Athericidae			Atherix	Atherix	
		Blephariceridae			Blepharicera	Blepharicera	
		Ceratopogonidae					
					Alluaudomyia	Alluaudomyia	
					Bezzia	Bezzia	
					Ceratopogon	Ceratopogon	
					Culicoides	Culicoides	
					Helius	Helius	
					Mallochohelea	Mallochohelea	
					Probezzia	Probezzia	
					Sphaeromias	Sphaeromias	
		Chaoboridae			Chaoborus	Chaoborus	
		Chironomidae					
			Chironimae			Chironimae	Chir
					Chironimini	Chironimni	Chir
					Chironomus	Chironomus	Chir
					Cladopelma	Cladopelma	Chir
					Cryptochironomus	Cryptochironomus	Chir
					Cryptotendipes	Cryptotendipes	Chir
					Cryptochironomus	Cryptochironomus	Chir
					Cryptotendipes	Cryptotendipes	Chir
					Dicrotendipes	Dicrotendipes	Chir
					Endochironomus	Endochironomus	Chir
					Glyptotendipes	Glyptotendipes	Chir
					Kiefferulus	Kiefferulus	Chir
					Microtendipes	Microtendipes	Chir
					Omisus	Omisus	Chir
					Parachironomus	Parachironomus	Chir
					Paracladopelma	Paracladopelma	Chir
					Paralauterborniella	Paralauterborniella	Chir
					Paratendipes	Paratendipes	Chir
					Saetheria	Saetheria	Chir
					Stenochironomus	Stenochironomus	Chir
					Stictochironomus	Stictochironomus	Chir
					Phaenopsectra	Phaenopsectra	Chir
					Polypedilum	Polypedilum	Chir
					Tribelos	Tribelos	Chir

Table B-1. Cont'd							
Class	**Order**	**Family**	**Subfamily**	**Tribe**	**Genus**	**Final ID**	**Note**
				Tanytarsini		Tanytarsini	Tant
					Cladotanytarsus	Cladotanytarsus	Tant
					Micropsectra	Micropsectra	Tant
					Paratanytarsus	Paratanytarsus	Tant
					Rheotanytarsus	Rheotanytarsus	Tant
					Stempellinella	Stempellinella	Tant
					Sublettea	Sublettea	Tant
					Tanytarsus	Tanytarsus	Tant
					Zavrelia	Zavrelia	Tant
			Diamesinae			Diamesinae	Diam
					Diamesa	Diamesa	Diam
					Pagastia	Pagastia	Diam
					Potthastia	Potthastia	Diam
					Sympotthastia	Sympotthastia	Diam
					Syndiamesa	Syndiamesa	Diam
			Orthocladiinae			Orthocladiinae	Orth
					Brillia	Brillia	Orth
					Cardiocladius	Cardiocladius	Orth
					Chaetocladius	Chaetocladius	Orth
					Corynoneura	Corynoneura	Orth
					Cricotopus	Cricotopus	Orth
					Cricotopus/Orthocladius	Cricotopus/Orthocladius	Orth
					Diplocladius	Diplocladius	Orth
					Eukiefferiella	Eukiefferiella	Orth
					Heleniella	Heleniella	Orth
					Heterotrissocladius	Heterotrissocladius	Orth
					Hydrobaenus	Hydrobaenus	Orth
					Limnophyes	Limnophyes	Orth
					Lopescladius	Lopescladius	Orth
					Nanocladius	Nanocladius	Orth
					Orthocladius	Orthocladius	Orth
					Orthocladiinae A	Orthocladiinae A	Orth
					Orthocladiinae B	Orthocladiinae B	Orth
					Parachaetocladius	Parachaetocladius	Orth
					Parakiefferiella	Parakiefferiella	Orth
					Parametriocnemus	Parametriocnemus	Orth
					Paraphaenocladius	Paraphaenocladius	Orth
					Paratrichocladius	Paratrichocladius	Orth
					Psectrocladius	Psectrocladius	Orth
					Pseudorthocladius	Pseudorthocladius	Orth
					Psilometriocnemus	Psilometriocnemus	Orth
					Rheocricotopus	Rheocricotopus	Orth

Symposiocladius	Symposiocladius	Orth

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
					Rheosmittia	Rheosmittia	Orth
					Thienemanniella	Thienemanniella	Orth
					Tvetenia	Tvetenia	Orth
					Unniella	Unniella	Orth
					Xylotopus	Xylotopus	Orth
			Prodiamesinae		Odontomesa	Odontomesa	Prod
					Prodiamesa	Prodiamesa	Prod
			Tanypodinae			Tanypodinae	
					Ablabesmyia	Ablabesmyia	Tanp
					Apsectrotanypus	Apsectrotanypus	Tanp
					Clinotanypus	Clinotanypus	Tanp
					Conchapelopia	Conchapelopia	Tanp
					Krenopelopia	Krenopelopia	Tanp
					Labrundinia	Labrundinia	Tanp
					Larsia	Larsia	Tanp
					Macropelopia	Macropelopia	Tanp
					Meropelopia	Meropelopia	Tanp
					Natarsia	Natarsia	Tanp
					Nilotanypus	Nilotanypus	Tanp
					Paramerina	Paramerina	Tanp
					Pentaneura	Pentaneura	Tanp
					Procladius	Procladius	Tanp
					Rheopelopia	Rheopelopia	Tanp
					Tanypus	Tanypus	Tanp
					Thienemannimyia	Thienemannimyia	Tanp
					Trissopelopia	Trissopelopia	Tanp
					Zavrelimyia	Zavrelimyia	Tanp
		Culicidae			Aedes	Aedes	
		Dixidae			Dixa	Dixa	
		Dolichopodidae					
		Empididae					
					Chelifera	Chelifera	
					Clinocera	Clinocera	
					Hemerodromia	Hemerodromia	
		Ephydridae					
		Muscidae					
					Limnophora	Limnophora	
		Psychodidae			Pericoma	Pericoma	
		Ptychopteridae			Bittacomorpha	Bittacomorpha	
		Simuliidae					
					Cnephia	Cnephia	
					Prosimulium	Prosimulium	
					Simulium	Simulium	
					Stegopterna	Stegopterna	

Table B-1. Cont'd

Class	Order	Family	Subfamily	Tribe	Genus	Final ID	Note
		Stratiomyidae			Stratiomys	Stratiomys	
		Tabanidae					
					Chrysops	Chrysops	
					Tabanus	Tabanus	
		Tipulidae					
					Antocha	Antocha	
					Cryptolabis	Cryptolabis	
					Dicranota	Dicranota	
					Erioptera	Erioptera	
					Hexatoma	Hexatoma	
					Limnophila	Limnophila	
					Limonia	Limonia	
					Molophilus	Molophilus	
					Ormosia	Ormosia	
					Pilaria	Pilaria	
					Pseudolimnophila	Pseudolimnophila	
					Tipula	Tipula	

1. Nematomorpha is a phylum level identification. No class level identification was made.
2. Brinkhurst (1986). ITIS (1998) places the family in the order Haplotaxida.
3. Margulis and Schwartz (1988). ITIS (1998) uses the class name Bivalvia.
4. Merritt and Cummins (1996). ITIS (1998) places *Perlesta* in the family Chloroperlidae.
5. Merritt and Cummins (1996). ITIS (1998) uses the genus name *Agnetina*.
6. Merritt and Cummins (1996). ITIS (1998) uses the order name Heteroptera.
7. Merritt and Cummins (1996). ITIS (1998) places Sisyridae in the order Megaloptera.
8. Merritt and Cummins (1996). ITIS (1998) places *Phylocentropus* in the family Psychomyiidae.
9. Merritt and Cummins (1996). ITIS (1998) places *Neophylax* in the family Limnephilidae.

Tanp Subfamily Tanypodinae
Orth Subfamily Orthocladiinae
Chir Tribe Chironominae
Tant Tribe Tanytarsini
Diam Subfamily Diamesinae
Prod Subfamily Prodiamesinae